United States
Department of
Agriculture

**Agricultural
Research
Service**

June 1990

New ARS Cereal Scientists Workshop

Pocatello, Idaho
May 22-24, 1990

REPORT

NEW ARS CEREAL SCIENTISTS

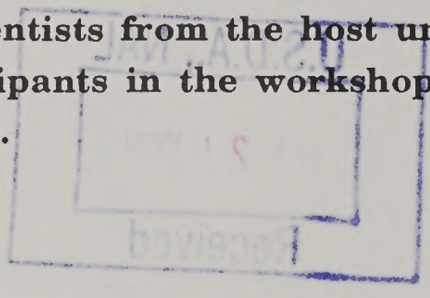
WORKSHOP

POCATELLO, IDAHO

MAY 22-24, 1990

NEW ARS CEREAL SCIENTISTS WORKSHOP

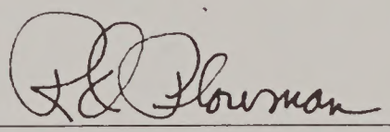
This first of a kind workshop brought together researchers from a diverse range of scientific backgrounds. Each, though, is engaged in research relating to the production and/or quality of a cereal grain (corn, sorghum, wheat, oats, barley, or rice) and each has been in his or her position five years or less. In fact, more than four percent have been in their current positions less than two years. Besides the 37 ARS researchers, two new cereal scientists from the host university (the University of Idaho) were full participants in the workshop. A full list of attendees is included in this report.



United States Department of Agriculture
Agricultural Research Service
National Program Staff
Beltsville, Maryland 20705

New ARS Cereal Scientists Workshop

It was a special pleasure for me to participate in the New ARS Cereal Scientists Workshop. The Agricultural Research Service (ARS) has a rich history of remarkable contributions, and I am proud of its many accomplishments. More important, though, is my confidence in the ability of ARS scientists to meet the challenges and solve the problems of tomorrow. The high caliber of the individuals who have recently been brought into ARS cereal crops research is evidenced in this report. This sample of the new generation of ARS scientists can serve as a model as we continue to recruit for the future, and this special workshop stands as an excellent example of the synergism that occurs when outstanding scientists with differing specialties but common objectives are brought together to discuss problems of mutual interest. I commend all workshop participants for this excellent effort.



R. D. Plowman
Administrator

First Row (seated left to right): A. Hewings, G. Hareland, L. Grant, L. Dahleen, P. Jauhar, D. Livingston, R.D. Plowman, S. Leath, M. McMullen, K. Walker-Simmons, R. Shukle, D. Hoffman, R. Graybosch, P. Sisco; **Second Row**: G. Banowetz, S. Ramagopal, S. Pinson, L. Pollak, C. Henson, L. Urie, A. Hang, P. Bregitzer, E. Civerolo, P. Ueng, H. Bockelman, K. Lamkey, R. French, B. Goates; **Third Row**: L. Domier, S. Gray, M. Edwards, W. Chace, D. Porter, R. Wise, C. Morris, R. Skadsen, V. Rayboy, M. Carson, E. Kendrick, J. Pederson, C. Murphy, L. Szabo, R. Zemetra. (Not pictured: O. Anderson, D. Wesenberg, and C. Barnes.)

LIST OF PARTICIPANTS

NEW ARS CEREAL SCIENTISTS WORKSHOP

California	
Olin D. Anderson	Western Regional Research Center, Albany, California
Idaho	
Darrell Wesenberg*	Small Grains and Potato Germplasm Research, Aberdeen
Harold E. Bockelman	"
Phillip Bregitzer	"
Blair Goates	"
An Hang	"
David L. Hoffman	"
A. Lee Urie	"
Subbanaidu Ramagopal	"
Edward Souza	University of Idaho, Aberdeen
Robert S. Zemetra	University of Idaho, Moscow
Illinois	
Leslie L. Domier	Crop Protection Research, Urbana
Adrianna D. Hewings	"
Indiana	
Richard H. Shukle	Insect and Weed Control Research, W. Lafayette
Iowa	
Kendall R. Lamkey	Cereal and Soybean Research, Ames
Linda M. Pollak	"
Roger Wise	"
Maryland	
Peter Ueng	Plant Molecular Biology Laboratory, Beltsville
Minnesota	
Les J. Szabo	Cereal Rust Research, St. Paul
Montana	
Victor Raboy	Cereal Crop Improvement Research, Bozeman
Nebraska	
Roy C. French	Wheat, Sorghum & Forage Research, Lincoln
Robert A. Graybosch	"
Jeffery F. Pederson	"

*Host Research Leader

New York	
Stewart M. Gray	Plant Protection Research, Ithaca
North Carolina	
Martin Carson	Plant Science Research, Raleigh
Steven Leath	"
Paul H. Sisco	"
North Dakota	
Lynn Dahleen	Cereal Crops Research, Fargo
Michael C. Edwards	"
Linda Grant	"
Gary Hareland	"
Ohio	
Michael D. McMullen	Corn and Soybean Research, Wooster
Oklahoma	
David Porter	Wheat and Other Cereal Crops Research, Stillwater
Oregon	
Gary M. Banowetz	Forage Seed and Cereal Research, Corvallis
Pennsylvania	
David P. Livingston	U.S. Regional Pasture Research Lab, University Park
Texas	
Shannon R. M. Pinson	Rice Research, Beaumont
Utah	
Prem P. Jauhar	Forage and Range Research, Logan
Washington	
Craig Morris	Wheat Genetics, Quality, Physiology and Disease Research, Pullman
Mary Walker-Simmons	"
Wisconsin	
Cynthia A. Henson	Cereal Crops Research, Madison
Ronald W. Skadsen	"
Pacific West Area	
William G. Chace, AD*	

*Host Area Director

National Program Staff

Edwin L. Civerolo	NPL, Plant Pathology
Charles F. Murphy	NPL, Grain Crops

Other

Edgar L. Kendrick	ARS (Retired), Tucson, AZ

Congress

Charles Barnes	Representative from the office of The Honorable Richard H. Stallings, U. S. House of Representatives, State of Idaho

Administrator

R. Dean Plowman	ARS Administrator, Washington, D.C.

NEW ARS CEREAL SCIENTISTS WORKSHOP

May 22-24, 1990
Pocatello, Idaho

WORKSHOP AGENDA

Monday, May 21, 1990

Evening - Registration

Tuesday, May 22, 1990

Presiding: C. F. Murphy

8:15 a.m.	Welcome	C. F. Murphy W. G. Chace D. Wesenberg
8:30 a.m.	Comments and Discussion	R. D. Plowman
9:00 a.m.	Introductions NPS, Information, Congressional	C. F. Murphy
9:15 a.m.	Introductory Presentations Harold E. Bockelman (Aberdeen, ID) Phillip Bregitzer (Aberdeen, ID) Blair Goates (Aberdeen, ID) David L. Hoffman (Aberdeen, ID) A. Lee Urie (Aberdeen, ID) An Hang (Aberdeen, ID) Subbanaidu Ramagopal (Aberdeen, ID) Edward Souza (Aberdeen, ID) Robert Zemetra (Moscow, ID)	
10:00 a.m.	BREAK	
10:30 a.m.	Introductory Presentations Adrianna D. Hewings (Urbana, IL) Leslie L. Domier (Urbana, IL) Richard H. Shukle (W. Lafayette, IN) Kendall R. Lamkey (Ames, IA) Linda M. Pollak (Ames, IA) Roger Wise (Ames, IA) Peter Ueng (Beltsville, MD) Les J. Szabo (St. Paul, MN) Victor Raboy (Bozeman, MT) Roy C. French (Lincoln, NE) Robert A. Graybosch (Lincoln, NE) Jeffery F. Pederson (Lincoln, NE)	

Tuesday, May 22, 1990 (continued)

11:30 a.m.	Adjourn	
11:45 a.m.	LUNCH	
1:15 p.m.	Introductory Presentations Stewart M. Gray (Ithaca, NY) Martin Carson (Raleigh, NC) Steven Leath (Raleigh, NC) Paul H. Sisco (Raleigh, NC) Lynn Dahleen (Fargo, ND) Michael C. Edwards (Fargo, NC) Linda Grant (Fargo, ND) Gary Hareland (Fargo, ND) Michael D. McMullen (Wooster, OH) David Porter (Stillwater, OH) Gary M. Banowetz (Corvallis, OR) David R. Livingston (University Park, PA)	
2:15 p.m.	BREAK	
2:30 p.m.	Introductory Presentations Shannon R. M. Pinson (Beaumont, TX) Prem P. Jauher (Logan, UT) Craig Morris (Pullman, WA) Mary Walker-Simmons (Pullman, WA) Cynthia Henson (Madison, WI) Ronald W. Skadsen (Madison, WI)	
3:00 p.m.	Comments, Reactions, etc.	Group
3:15 p.m.	BREAK	
3:30 p.m.	ARS Cereal Crops Research - Some History	E. L. Kendrick
4:00 p.m.	Discussion	
4:20 p.m.	Adjourn	
7:30 p.m.	DINNER	

Wednesday, May 23, 1990

7:45 a.m.	Bus departs to Aberdeen	
8:30 a.m.	Tour National Small Grains Germplasm Research Facility	
11:00 a.m.	Bus departs to Pocatello	
12:00 noon	LUNCH	

Wednesday, May 23, 1990 (continued)

Presiding: E. L. Civerolo

1:15 p.m.	Charge to break-out groups (see attached list)	E. L. Civerolo
1:25 p.m.	Break-Out Sessions (see Break-Out Agenda)	
5:00 p.m.	Adjourn	
7:30 p.m.	DINNER	

Thursday, May 24, 1990

Presiding: E. L. Civerolo

8:00 a.m.	Break-out teams continue discussions and work on reports
9:30 a.m.	Report from Group A
10:15 a.m.	BREAK
10:30 a.m.	Report from Group B
11:15 a.m.	Report from Group C
12:00 noon	Comments
12:15 p.m.	LUNCH

Afternoon

This time is allotted for small work sessions to be arranged by participants. Example topics include:

BYDV	Germplasm Evaluation and Maintenance
Soilborne Viruses	Wheat Classification
Cereal Smuts	Value Added Traits in Oats, Rice, and Barley
Russian Wheat Aphid	Gene Mapping
Hessian Fly	Stress Tolerance
Stalk Rot of Corn	Core Collection Philosophies
Regional Nurseries	

5:00 p.m.	Final Adjournment
7:30 p.m.	DINNER

Friday, May 25, 1990

Travel

BREAK-OUT AGENDAS

Group A (Improving Value-Added Traits)

	Sub-Topic	Discussion Leader(s)
1:25 p.m.	Fiber Characteristics	R. Skadsen L. Szabo
2:30 p.m.	Wheat Quality for the Future	R. Graybosch G. Hareland
3:45 p.m.	Specialty Traits (starch granule size, subtle flavors in rice, phytic acid, etc.)	V. Raboy S. Pinson
5:00 p.m.	Adjourn	

Group B (Protecting Plants from Pests and Pathogens)

	Sub-Topic	Discussion Leader(s)
1:25 p.m.	Cereal Viruses	A. Hewings S. Gray
2:15 p.m.	Fungal Diseases	S. Leath M. Carson
3:15 p.m.	Cereal Insects	R. Shukle D. Porter
4:00 p.m.	Genetics of Resistance	R. Wise R. French
5:00 p.m.	Adjourn	

Group C (Yield Efficiency and Breeding Methodology)

	Sub-Topic	Discussion Leader(s)
1:25 p.m.	Stress Tolerance and Senescence	K. Simmons D. Livingston
2:15 p.m.	Gene Transfer Technology	L. Dahleen M. McMullen
3:15 p.m.	Gene Mapping	P. Sisco D. Hoffman
4:00 p.m.	Breeding, Methodology and Cytogenetics	K. Lamkey A. Hang
5:00 p.m.	Adjourn	

Group A	Group B	Group C
Bregitzer	Bockelman	Hang
Urie	Goates	Ramagopal
Hoffman	Hewings	Souza
Pollak	Domier	Lamkey
Szabo	Shukle	Pederson
Graybosch	Wise	Sisco
Raboy	Ueng	Dahleen
Hareland	French	McMullen
Grant	Gray	Banowetz
Pinson	Leath	Livingston
Morris	Carson	Jauhar
Skadsen	Edwards	Simmons
Henson	Porter	Zemetra

It will be the responsibility of the discussion leaders to lead the designated discussion so as to address objectives and produce a product as follows:

Objectives:

1) Identify priority research areas

2) **Identify research needs and approaches**

3) Identify new and/or potential cooperative links (inter- or intra-agency) to more effectively carry out this research

Expected Product: Report (bullet format) -- not to exceed three pages

NEW ARS CEREAL SCIENTISTS WORKSHOP

POCATELLO, IDAHO

PROJECT SUMMARIES

New ARS Cereal Scientists Workshop

Summary

Name: Olin D. Anderson

Management Unit: Plant Development - Quality

Location: Albany, California

Strategic Plan Code: 4.1.02.1.a 50%
4.1.02.1.b 50%

Objectives/Approach:

A) Characterize the wheat storage protein gene families. B) Identify regions of the wheat genome that control the timing and specific localization of storage protein gene expression in the wheat seed and determine the molecular basis of such control. C) Determine a suitable transformation strategy leading to novel and improved wheat products.

Status of Research:

All six high-molecular-weight (HMW) glutenin genes have been isolated and sequenced from the hard red winter wheat cultivar Cheyenne, and the other storage protein gene families have similarly been analyzed. Selected genes are being expressed in yeast, vertebrate oocytes, and bacteria to study the unique physical-chemical properties of these proteins and to study the intermolecular disulfide crosslinking patterns which play a significant role in wheat dough quality. The different heterologous systems allow different parameters to be studied either by producing larger amounts of a specific protein, or by following the post-translation processing of the single wheat protein. Mutagenized and hybrid genes are allowing specific protein domains to be correlated with storage protein properties.

A maize endosperm cell line supports transient HMW-glutenin gene expression, allowing our unit to make a crude map of the 5′ regulatory sequences important in gene expression. A finer map is underway and will be used in attempts to both understand the basis of endosperm specific transcription and to develop modifications leading to enhanced gene activity. This information will also be used in identifying trans-acting factors involved in specific endosperm gene expression.

A study of the mechanisms and efficiency of gene transfer is underway using rice as a model for the cereal crops. Protoplast regeneration has been established in our laboratory and transgenic experiments are underway. Selectable markers are currently being tested on rice cultures. The rice system will also be used to study the control of expression of selected wheat genes, and the processing of individual wheat storage proteins in the rice system.

Name: Harold E. Bockelman

Management Unit: Small Grains and Potato Germplasm Research

Location: Aberdeen, Idaho

Strategic Plan Code: 2.1.01.1.c 50%
2.1.01.1.d 50%

Objectives/Approach:

1) Evaluate core collection concepts in the National Small Grain Collection; 2) develop improved regeneration strategies, including development of methods to insure maintenance of maximum genetic diversity in each NSGC accession when increasing seed stocks; 3) determine the genetics and inheritance of vesicular-arbuscular mycorrhizal (VAM) colonization and response in wheat; and 4) develop enhanced wheat germplasm with increased response to VAM colonization.

In addition, the following activities are associated with the NSGC: meticulous maintenance, as indicated by seed availability, viability, and freedom from seedborne and other pathogens and pests, of all NSGC germplasm accessions; distribution, upon request, of seed of NSGC accessions worldwide; maintenance of NSGC passport and evaluation data in the Germplasm Resources Information Network (GRIN); and acquisition of new small grains germplasm for the NSGC.

Status of Research:

Techniques for efficient inoculation and precise measurement of colonization and response in wheat to VAM were developed. Differences in levels of colonization among different soft red winter wheat cultivars were demonstrated. Cultivar differences in growth and yield response to inoculation with a VAM fungus were demonstrated under both greenhouse and field conditions. Responses have ranged from -5% to +25% with response strongly influenced by environment. Careful control of environmental conditions should allow selection of genotypes with high response to VAM. The extent of naturally-occurring VAM in winter wheat production areas in the eastern third of the U.S. was determined by surveying 12 locations. VAM was found associated with wheat at every location. Colonization was generally at low levels, but varied widely.

Protocols are being established for all aspects of operations at NSGC including, acquisition, maintenance, seed increases, and seed viability. Updating of passport information entered in the Germplasm Resources Information Network (GRIN) has been initiated. While traveling in Yugoslavia in September-October, 1989, an OICD/FCR project proposal was developed with Yugoslav scientists to identify drought tolerant wheat germplasm. This will result in the acquisition of valuable germplasm of Yugoslav origin for the NSGC with potential drought tolerance: Eighty-two barley accessions were obtained from the collection in the German Democratic Republic with resistance to race 24 of Puccinia striiformis. Nearly 100,000 accessions were distributed in the past year.

New ARS Cereal Scientists Workshop

Summary

Name: Phil Bregitzer

Management Unit: Small Grains and Potato Germplasm Research

Location: Aberdeen, Idaho

Strategic Plan Code: 2.1.01.1.e 80%; 2.2.01.1a 20%

Objectives / Approach:

To improve production efficiency of barley in North America via identification and introduction of useful genetic variation from unadapted cultivars, wild species, and from in vitro cell cultures.

Barley cell culture will focus on identifying genetic material capable of long term regeneration of fertile plants, identifying optimum culture conditions to facilitate long term plant regeneration, and the development of elite barley germplasm posessing superior culturing characteristics.

In cooperation with Dr. An Hang, wide hybridization will be employed to introgress useful traits into barley from related species within Triticieae. Tissue culture will be utilized to aid the recovery of useful variation; embryo rescue will be employed to increase the recovery of potentially useful hybrids, and callus culture as a means of inducing nonhomologous recombination will be used to increase recombination between unrelated genomes.

Methods will be developed to evaluate germplasm for tolerance to drought conditions. These methods will be useful for evaluating the NSGC barley accessions, and and developing genotypes capable of good performance under conditions of limited water input.

Status of Research:

Program was initiated in July, 1989, and a laboratory equipped for cereal tissue culture research has largely been put into place. 12,000 embryos from 15 genotypes (primarily from elite varieties) are being assayed for callus initiation and plant regeneration. Vigorous cultures have been established from most genotypes, although regenerated plants from several genotypes are primarily albino; mitotic analysis of several albinos has not detected gross chromosomal abnormalities.

A program involving hybridization of barley with Hordeum bulbosum genotypes posessing good resistance to Russian Wheat Aphid damage has been initiated in cooperation with Dr. An Hang and Dr. Dean Kindler (Stillwater, Oklahoma) to attempt transfer of this tolerance to barley. Several stable H. vulgare x H. bulbosum hybrids have been backcrossed to Bowman, and a good frequency of seed development has been observed.

New ARS Cereal Scientists Workshop

Summary

Name: Blair J. Goates

Management Unit: Small Grains and Potato Germplasm Research

Location: Aberdeen, Idaho

Strategic Plan Code: 2.1.01.1.c 25%
2.1.01.1.d 75%

Objectives / Approach:

Determine dwarf bunt disease reaction of wheat entries from the National Small Grains Collection, and of breeding lines from various state and private programs. New wheat entries from the NSGC, and breeding lines solicited from winter wheat breeders are tested annually in an artificially inoculated field nursery located at Logan, Utah.

Evaluate bunt resistance genes of resistant NSGC entries for useful and/or previously unidentified genes. Bunt collections that contain unique virulence are utilized to determine resistance genes.

Survey oat and barley germplasm for isozyme polymorphism. Twenty-six cultivars of Hordeum vulgare, 3 accessions of H. spontaneum, 21 cultivars of Avena sativa, 2 accessions each of A. sterilis and A. fatua, and several diploid and tetraploid oat species are screened with previously untested enzyme systems using horizontal starch gel electrophoresis.

Maintain the NSGC free of seed-borne pathogens. Quarantine and increase nurseries are monitored for disease.

Assist in the evaluation of morphologic and agronomic characters of NSGC material.

Status of Research:

After several years of dwarf bunt tests, only 15 lines of Triticum aestivum have been identified that possess high levels of resistance to a broad base virulence. Of 827 new lines from the NSGC, 13 showed resistance in 1988 and are being retested. Approximately 355 new lines from the NSGC which includes 260 lines of a collection from Turkey, are in this years dwarf bunt nursery. The soft white winter and hard red spring Western Regional Nurseries, and approximately 800 lines from breeders are screened annually.

Evaluation of bunt resistance genes from resistant entries will begin in the fall of 1990.

Three new polymorphic isozymes have been genetically characterized in cultivated barley. Eleven enzyme systems previously unreported for oats have been identified that each have polymorphism for one or more isozymes in cultivated oats. Additional enzyme systems will be tested on oats. Preliminary tests have shown a high degree of polymorphism among diploid and tetraploid oat species.

New ARS Cereal Scientists Workshop

Summary

Name: David Hoffman

Management Unit: Small Grains and Potato Germplasm Research

Location: Aberdeen, Idaho

Strategic Plan Code: 2.1.01.1.d 80%
2.1.01.1.e 20%

Objectives / Approach:

To determine the feasibility of DNA restriction fragment length polymorphism (RFLP) for genetic analysis and germplasm enhancement in oats; to initiate a linkage map of oats using conventional and molecular markers; and to initiate linkage determinations or associations or molecular markers with genes controlling agronomic traits.

Clones from an oat genomic DNA library will be screened for copy number. Low copy number clones will be evaluated for detecting polymorphism among a diverse set of cultivars. Linkage among markers and economic traits will be codetermined using recombinant inbred populations derived from wide crosses. Chromosomal assignments of linkage groups will be accomplished with a monosomic series.

Status of Research:

A study of RFLP among nine diverse oat cultivars has been completed. Of 32 clones surveyed, three were multiple copy. Of the 29 low copy clones, 26 were polymorphic. Higher amounts of RFLP were noted between Avena sativa and A. byzantina cultivars than among cultivars of each species. 'Sun II' and 'TAM 301' were the most polymorphic pair. From the level of polymorphism observed, it is likely that RFLPs will be useful for chromosome mapping and gene tagging in oats.

Recombinant inbred lines of an 'Ogle'/'Brooks' cross have been advanced to the F_6 by single seed descent. The F_7 will be planted in the field in the spring of 1990 and be evaluated for heading date, plant height, seed-fill duration, biological yield, seed yield, harvest index, test weight, and groat percentage. The same lines will also be scored for morphological, isozyme, and RFLP variation. Linkages among the markers will be determined as well as associations between markers and genes controlling agronomic traits. Recombinant inbred lines of a 'Border'/A. fatus are also being developed by single seed descent.

Other studies just getting underway include a study of the conservation of genetic linkages between oats and barley plus a survey of isozyme polymorphism among oat cultivars and related wild species.

New ARS Cereal Scientists Workshop

Summary

Name: A. Lee Urie

Management Unit: Small Grains and Potato Germplasm Research

Location: Aberdeen, Idaho

Strategic Plan Code: 2.1.01.1.c 50%
2.1.01.1.d 50%

Objectives / Approach:

Assists curator with the maintenance of all National Small Grains Collection (NSGC) germplasm accessions. Is responsible for filling seed requests of NSGC accessions. These requests are processed as orders through the Germplasm Resources Information Network (GRIN) system. Supervises several workers who process a large volume of orders. Works closely with ARS staff with responsibilities for germplasm evaluation and enhancement.

Status of Research:

Nearly 100,000 accessions were distributed worldwide in the past year. Both public and private institutions are utilizing the collection to screen for diseases, insects, salt tolerance, tolerance to herbicides, and other environmental stresses.

Evaluation nurseries have been grown at Maricopa, Arizona and Aberdeen, Idaho. Descriptors (as determined by Crop Advisory Committees) have been recorded on these nurseries during the growing season. Training has been received in classification of wheat species as well as barley and oat plant types and head and panicle characteristics.

Summary

Name: An Hang

Management Unit: Small Grain and Potato Germplasm Research

Location: Aberdeen, Idaho

Strategic Plant Code: 2.1.01.1.e 80%
2.2.01.1.a 20%

Objective / Approach:

To improve understanding of genetic mechanisms in order to facilitate enhancement of barley germplasm for qualitative and quantitative traits for economic importance.

Different aneuploid lines of barley including primary trisomic, telotrisomic, acrotrisomic, and other fragment trisomics will be utilized to study the chromosomal contributions to morphology and to development of plant through dosage effects.

To identify favorable characteristics such as disease resistance from related species (Hordeum bulbosum, H. spontaneum, H. chilense) and to transfer these characteristics to cultivated barley through interspecific and intergeneric hybridizations.

Other objectives including associating new Mendelian genes to specific chromosomes or to chromosome arms by trisomic or telotrisomic analysis.

Status of Research:

A barley with 2n=18 chromosomes was developed through crossing between two lines of 2n=16 chromosomes. This barley (2n=18) carries a small duplicated segment of chromosome 3. Since chromosome 3 in barley under trisomic condition does not show any deteriorating effects on the plant development, the 2n=18 plant is completely fertile. Preliminary studies indicated that seed fertility and seed weight of this new barley were higher than that of the parental cultivar. Different lines of 2n=18 plants are growing in the greenhouse to cross with various elite cultivars such as Klages, Crystal, Bowman, Hector, and Morex. Chromosome number of the F1 and F2 plants will be cytologically verified and only plants with 2n=18 will be selected. Once favorable characteristics are recognized, they will be evaluated for disease reactions and for other agronomic characters.

Maintenance and increase of some aneuploid and mutant stock are also part of my work.

New ARS Cereal Scientists Workshop

Summary

Name: S. Ramagopal

Management Unit: Small Grains and Potato Germplasm Research

Location: ARS National Small Grains Germplasm Research Facility, Aberdeen, Idaho

Strategic Plan Code: 2.2.01.1.b 60%
2.3.01.1.1 40%

Project Title: Molecular Biology of Cereal Genome and Improvement of Stress Tolerance in Wheat Germplasm

OBJECTIVES:

(1) Identify cereal genes regulating tolerance to osmotic stress due to drought and salinity.

(2) Isolate and characterize the structure, function and regulation of genes conferring stress-tolerance from wheat germplasm.

(3) Evaluate and enhance wheat germplasm for drought/salinity tolerance by genetic engineering.

APPROACH:

Proteins induced or altered by water/salt stress will be identified in plants or cell cultures selected from Triticeae or other gramineaceous germplasm by in vivo labeling techniques, or by in vitro translation of mRNA followed by two dimensional polyacrylamide gel electrophoresis. Genes encoding the stress-altered proteins will be isolated by constructing and screening gene libraries from appropriate genotypes and tissues. Chromosomal segments regulating the expression of drought/salinity tolerant genes will be identified by cell transformation and analysis of transgenic plants. Studies may also be initiated to evaluate the germplasm collection for the presence of potent stress tolerant genes, their inheritance pattern, and the transfer of such genes to elite wheat cultivars by genetic engineering.

Status of Research:

This is a new program. The principal investigator is currently in the process of establishing the laboratory and initiating the research.

Research Responsibilities Edward Souza

Job Description: Assistant Research Professor of Plant Breeding and Genetics, Department of Plant, Soil, and Entomological Sciences, Aberdeen Research and Extension Center.

Definition: Responsible for a comprehensive program of research and development of winter wheats for southern Idaho and spring wheats for all of Idaho. In conjunction with cultivar development responsible for research into plant breeding methodology and basic genetics of wheat.

Duties: Research 100%
Allocation of time:

A) Dry-land Hard Red Winter Wheat Development (40% time): Responsible for the breeding program to select high yield, disease resistant cultivars for dry-land farms of southern Idaho. The program includes 1) a crossing program, 2) genotype selection, 3) cultivar testing program at four test sites in southeastern Idaho, 4) evaluation of milling and baking quality, 5) disease screens, both field for snow mold, dwarf bunt, and stripe rust resistance, as well as greenhouse screens for snow mold resistance, 6) participate in multi-state regional nursery testing of the most elite breeding lines, and 7) development of new divergent germplasm for the Pacific northwest through use of recurrent selection populations. For all market classes of wheat, milling and baking quality evaluations are conducted jointly with the Idaho Wheat Quality Lab and disease screens jointly with a USDA support scientist.

B) Soft White Spring Wheat Development (20% time): Responsible for the breeding program to develop soft white spring wheats for irrigated farmlands and high rainfall areas of Idaho. The program outline is similar to the hard red winter wheat program. Major breeding goals are to develop high yield, lodging resistant wheats with superior soft wheat milling and baking quality, as well as resistance to stripe rust and black chaff.

C) Hard Red Spring Wheat Development (20% time): Responsible for the hard red spring wheat breeding program to develop wheat cultivars for high rainfall areas of Idaho, irrigated farmland, and spring reseeding of frost-killed winter wheat. The hard red spring wheat program for maximum-yield conditions requires the selection of stiff straw, semi-dwarf wheats with high protein seed, excellent bread baking quality, stripe rust resistance, black chaff tolerance, and high yield potential. Re-seeding acreage or low-rainfall areas require the development of cultivars with highly stable yield and test weight with early maturity.

D) Basic Breeding and Genetics Research (15% time): Responsible for basic research in the following areas: 1) inheritance of current sources of disease resistance in winter wheat, particularly snow mold, and identification of new sources (joint research with USDA support scientist), 2) identification of bread wheats with field resistance to the Russian wheat aphid (joint research with UI entomologists), 3) inheritance of black chaff tolerance and resistance (joint research with UI pathologists), 4) statistical methodology for parental selection and breeding line testing.

Name: Robert S. Zemetra

Soft White Winter Wheat Breeder

University of Idaho, Moscow, Idaho

Objectives:

To develop new cultivars of soft white winter wheat with improved quality, disease resistance, insect resistance and agronomic traits. Techniques include both conventional methods and the new plant biotechnologies including callus culture, anther culture and gene transformation. Diseases of interest include *Cercosporella* foot rot, dwarf bunt, Cephalosporium stripe, barley yellow dwarf and stripe rust. Current research on insect resistance is the identification and transfer of genes for resistance to the Russian wheat aphid (RWA). Work on the RWA includes germplasm screening, genetic analysis and cytogenetic analysis of RWA resistant wheat accessions.

Status of Research:

The breeding program has entered its sixth year and currently has all generations up to the F_5 in the field and/or greenhouse. Germplasm has been introduced from outside the Pacific Northwest to widen the genetic base of the breeding population. Selection in the F_3 and F_4 generations has emphasized quality characteristics.

Anther culture derived lines are currently in the field for evaluation of disease resistance, agronomic traits, and for seed increase. Disease resistances of interest are for *Cercosporella* foot rot and dwarf bunt. The lines will all be screened using electrophoresis to determine if they possess the gene for foot rot resistance.

For RWA resistance, 24 wheat accessions have been identified as possessing moderate resistance to the RWA. Six of these lines are currently under genetic analysis to determine the number of unique resistance genes. Monosomic analysis has been initiated to identify the chromosomes carrying the genes D_N1 and D_N2. Callus culture is being explored as a bioassay for RWA toxin activity and as a source of somaclonal variants tolerant/resistant to RWA toxin.

Callus culture and particle gun transformation are being used to transfer a BYDV coat protein gene into wheat. These initial experiments are to determine the usefulness of the particle gun to transfer disease resistance into wheat.

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New ARS Cereal Scientists Workshop
Summary

Name: **Adrianna Hewings**

Management Unit: **Crop Protection Research Unit**

Location: **Urbana, Illinois**

Strategic Plan Code: **2.2.03.1.c 50%, 2.2.03.1.f 50%**

Objectives / Approach:

To determine mechanisms of resistance or tolerance to barley yellow dwarf virus (BYDV); and to investigate the dynamics of BYDV spread; to determine the incidence and mix of BYDV viruses in selected oat and wheat genotypes.

Selected germplasm with a range of field responses to the BYDV-PAV-IL strain will be screened for field response to the three strains of the virus. Symptomatology, and several components of yield will be determined. The same material will be evaluated in the greenhouse and In a mist chamber to evaluate the effects of infection on root and shoot growth. Serology and cDNA probes will be used to quantify whole virus, viral protein subunits and nucleic acids to determine the effects of tolerant and susceptible lines on accumulation of virus in host tissues.

The presence of BYDV infection foci and the role of aphid colonization on intrafield virus spread will be studied in replicated field plots with four treatments: plots with evenly spaced infected plants infested with aphids (aphids, virus), the same treatment without aphids(virus, no aphids), plots with no infected plants infested with aphids (aphids, no virus) and plots with no infected plants and not infested with aphids (no virus, no aphids). At periodic intervals selected plants within each plot will be scored for 1) virus infection by symptomatology and by ELISA, and 2) the number and size of aphid colonies to determine the effects of vector establishment and initiation of disease foci on virus spread.

Status of Research:

Two tolerant (Ogle and IL 86-6404) and two susceptible (Clintland 64 and Larry) oat genotypes have been evaluated in the growth chamber mist box. Reductions in root and shoot weights and total root length were significantly greater in Larry and Clintland 64. IL 86-6404 suffered a significant percentage reduction for several growth parameters but the effects of the root damage caused by BYDV are apparently offset by abundant root growth such that the supply of water and nutrients was adequate for good performance Breeding for root vigor may help to reduce losses from BYDV.

Preliminary data indicate that virus spread occurred more rapidly in fields where infection foci were established prior to aphid infestation. Using electric grid powered and photovoltaic suction traps to capture live aphids, 17 different species of aphids, Including six known BYDV vectors were identified. *Rhopalosiphum padi,* vector of both the PAV- and RPV-like strains, was captured with greatest frequency, approximately 85% of the viruliferous *R. padi* transmitted the PAV serotype and 15% transmitted the RPV serotype. A few aphids transmitted both RPV and PAV serotypes. No MAV serotypes were observed.

Other studies in progress:

In the first year of a multiyear survey of BYDV incidence in Ogle and Larry oats and Caldwell and Cardinal wheat genotypes, 900 samples were collected from 11 oat and 7 wheat fields. Incidences of BYDV-PAV serotypes ranged from 0-42%, BYDV-RPV incidences ranged from 0-8%. Only 1 BYDV-MAV serotype was detected.

Dr. Phyllis Himmel, a post-doctoral research associate, in the Cereal Virology Group is conducting a field study of four soil borne wheat mosaic virus (SBWMV) susceptible and four resistant soft red winter wheat genotypes. She found detectable virus in all shoots and roots of susceptible cultivars. Detectable virus in the roots of resistant cultivars was greatly reduced suggesting that the mechanism of resistance may be tied to inhibition of replication or particle assembly resulting in reduced accumulation of virus in resistant roots.

New ARS Cereal Scientists Workshop

Summary

Name: Leslie L. Domier

Management Unit: Crop Protection Research

Location: Urbana, Illinois

Strategic Plan Code: 2.2.03.1.c 50%
2.2.03.1.f 50%

Objectives / Approach:

My research is divided into two areas: first, a study of the pathogenicity of barley yellow dwarf virus (BYDV) and second, a study of host tolerance to BYDV infection. To study the mechanisms by which the virus induces disease, the functions of the virus encoded proteins will be examined. cDNA clones representing the entire viral genome will be constructed and used to develop a genetic system for the analysis of gene functions and to produce antibodies so that the gene products can be examined immunologically.

Host genes encoding tolerance to BYDV infection will be identified using subtractive cloning procedures. cDNA libraries will be prepared from two oat cultivars, one very sensitive to BYDV infection and one very tolerant to BYDV infection. Single stranded cDNA from the tolerant cultivar will be hybridized to biotin-labelled single stranded cDNA form the sensitive cultivar. The hybridizing cDNAs will be removed by precipitation with streptavidin leaving the cDNA unique to the tolerant cultivar in solution. The cDNA will be used to retransformed into *E. coli.* Putative tolerance genes will be identified using individual cDNA clones to probe Southern Blots of DNA isolated from oat cultivars known to be segregating tolerance genes.

Status of Research:

Genomic RNA was purified from an Illinois isolate of the PAV stain of BYDV. The nucleotide sequence of the 3'-terminal 30 nucleotides of the RNA was determined by direct RNA sequencing. Using this information, an oligonucleotide primer complementary to the 3'-terminal 20 nucleotides of the BYDV genome was synthesized and used to prime cDNA synthesis. The cDNA was ligated into pBluescript and used to transform *E. coli.* Plasmids containing PAV-IL cDNA were isolated and the inserts mapped with restriction enzymes. The inserts were found to be 3'-coterminal. The longest insert, 5.6 kb, represented nearly full-length copy of the PAV-IL genome. Sequence analysis of the cDNA showed a greater than 90% identity with the sequence published by Allan Miller for an Australian PAV isolate.

The cDNA clones and sequence information are being used to generate antibodies to the BYDV nonstructural proteins using chemically synthesized peptides and proteins expressed in *E. coli.*

mRNA has been isolated from both healthy and infected tissue of three oat cultivars, Clintland 64, Ogle and IL86-1156. The three cultivars show a wide range of tolerance to BYDV infection with Clintland 64 being the most susceptible and IL86-1156 the most tolerant. cDNA libraries have been prepared from the "healthy" mRNAs and are ready for the subtractions.

New ARS Cereal Scientists Workshop

Name: Richard H. Shukle

Management Unit: Insect & Weed Control Research Unit

Location: West Lafayette, Indiana

Strategic Plan Code: 2.4.05.1.i (80%)
2.4.01.5.b (20%)

Current research:

The goal of research in this program is the protection of small grains from insects through genetic manipulation of the host plant and the insect. In our laboratory, the major research effort is directed toward: 1. understanding the molecular basis of virulence in the Hessian fly-wheat interaction, and 2. identifying genes for resistance that can be transferred via classical breeding or genetic engineering to produce insect-resistant plants.

Research objectives:

Research objectives with the Hessian fly-wheat interaction are: 1. to evaluate with low copy number clones the feasibility of using DNA restriction fragment length polymorphism (RFLP) for genetic analysis, and 2. to determine linkages or associations for molecular markers identified with genes controlling virulence in the insect.

Status of research:

Low copy number clones have been obtained from a partial genomic library. Selected clones are currently being evaluated for detecting polymorphism among Hessian fly biotypes.

Additionally, a small repetitive sequence that appears to differ among Hessian fly biotypes D, L and E has been cloned. A cDNA library is currently being constructed with poly A^+ mRNA obtained from early first instar Hessian fly larvae feeding on resistant plants.

New ARS Cereal Scientists Workshop

Summary

Name: Kendall R. Lamkey

Management Unit: Cereal and Soybean Improvement Research

Location: Ames, Iowa

Strategic Plan Code: 2.1.01.1.e 40%
2.2.03.1.a 60%

Objectives / Approach

To obtain basic information on the relative effectiveness of selection methods for genetic improvement of corn germplasm, types of genetic variability present in populations, methods for the evaluation, adaptation, and utilization of exotic germplasm, and methods to improve host-plant resistance to major pests.

Conduct long-term selection studies to compare rates of response to different selection methods; conduct genetic studies to estimate the types of genetic effects present in broad and narrow genetic base populations; conduct studies to determine appropriate methods for adaptation, incorporation, and evaluation of exotic germplasm, and conduct selection under artificial infestation and infection.

Status of Research:

A study designed to compare the response of seven recurrent selection methods and to determine the effect of four effective population sizes on response to selection is nearing completion. The study is unique because the selection methods are being compared in a common base population (BS11), using a common effective population size (20), and a common selection intensity (20%). The four effective population sizes (5, 10, 20, 30) are being compared using a common selection intensity (20%). The recurrent selection methods will be conducted for five cycles (completion expected in 1992) before evaluation of response will begin.

A study with the long term objective of determining if transposable elements generate new genetic variation that could enhance or maintain selection response in corn populations is currently in progress. Results from Iowa Stiff Stalk Synthetic (BSSS) have shown that the percentage of plants containing active Uq transposable elements increased from 19% (BSSS) to 91% [BSSS(S)C13] at a linear rate after 13 cycles of half-sib and S_2 progeny recurrent selection, whereas active Uq elements have become extinct between the fifth and sixth cycles of reciprocal recurrent selection. Additional studies are currently in progress.

Other studies currently in progress are: an extensive evaluation of 11 cycles of reciprocal recurrent selection; a comparison of methods for identifying source populations with unique favorable alleles not present in elite single-cross hybrids; a study designed to compare the changes in interpopulation variance after 11 cycles of reciprocal recurrent selection; and an extensive study of changes in intrapopulation variance components in BSSS. I also collaborate with Dr. Michael Lee on his RFLP project.

New ARS Cereal Scientists Workshop

Summary

Name: Linda Pollak

Management Unit: Cereal and Soybean Improvement Research

Location: Ames, Iowa

Strategic Plan Code: 2.1.01.1.d 100%

Objectives / Approach:

To evaluate corn germplasm collections to provide basic information in the extent and distribution of genetic diversity in these collections; and to participate as Principal Investigator and Information Manager for the USA and Caribbean in the Latin American Maize Project (LAMP).

Evaluation of corn germplasm accessions for productivity will be similar to standard approaches for improved materials and to protocol being followed in LAMP. Evaluation for other traits will be included as facilities, expertise, cooperators, and equipment are identified and available. Traits included in evaluations will be pest resistance, percentage of protein, oil and starch, wet-milling characteristics, grain quality traits, functional starch properties, and fatty acid analysis.

Status of Research:

The top 5% of accessions from all LAMP tropical lowland and temperate locations are being testcrossed to adapted testers in Puerto Rico and Iowa, respectively. Two stages of evaluations of Caribbean and USA accessions have been completed in Puerto Rico, Georgia and Iowa. Mid-Corn Belt yellow dent populations will be undergoing the second year of per se evaluation, while testcrosses of these populations to four heterotic patterns will be evaluated in Iowa. Cateto x Corn Belt single crosses are being evaluated for agronomic traits in a diverse set of environments, and will also be evaluated for physical grain characteristic to determine the effect of environment on these traits. The top 20% LAMP Caribbean accessions crossed to two Corn Belt single crosses will be evaluated for their potential to improve U.S. corn for both agronomic and grain quality traits.

Variablity for functional starch characteristics using differential scanning calorimetry has been found within and among a set of open-pollinated populations of diverse origin. This indicates that genetic variability for starch structure may exist within populations. A set of Corn Belt hybrids has been analyzed to determine the extent of variability for these characteristics in commercially obtainable corn.

New ARS Cereal Scientists Workshop

Summary

Name: Roger Wise

Management Unit: Cereal and Soybean Research Unit

Location: Ames, Iowa

Strategic Plan Code: 2.2.01.1.c 50%

2.4.02.1.g 50%

Problem to be addressed: Genetics and Molecular Biology of Host-Pathogen Interaction: Resistance to fungal pathogens in cereals

Fundamental knowledge of the genetics of host-pathogen interaction is critical in our utilization of genetic resistance to control plant diseases. Plant breeders are constantly incorporating new sources of resistance into crop plants in response to the continually changing pathogen populations. We are developing a new CRIS proposal to address the problem of the genetics and molecular biology of resistance to fungal pathogens in cereals. To date no gene product has been identified which is the specific product of a nuclear locus segregating as a disease controlling element. In addition, there is no biochemical explanation for the nature of disease resistance which has been confirmed by genetic analysis of alternate disease phenotypes.

Approach:

We are addressing this problem with three concurrent lines of research; RFLP mapping of disease resistance genes, development of monocot transformation systems, and transposon tagging and cloning of genes which can modify the resistance response. In the long term, all three are based upon a single unifying principle of identifying the primary genes or gene products which determine race specific resistance to fungal pathogens or can modify this interaction.

Objectives:

1. Construct an RFLP map of genes for rust resistance in *Avena strigosa* (diploid oats).

2. Investigation of pollen tube transformation in barley. Map individual transformants utilizing wheat - barley addition lines. Our long term goal is to introduce the *Ac-Ds* transposable system from maize for use in tagging genes for resistance to powdery mildew. We then would like to transfer this technology to oats for use in tagging and cloning of crown rust resistance genes and to assist in the generation of region specific RFLP markers.

3. Transposon tag and clone the *Rf2* nuclear gene for fertility restoration in T-cytoplasm male-sterile maize. Characterize role of *Rf2* in development of male fertile maize and relation to disease toxin sensitivity.

Status of Research: New project

New ARS Cereal Scientists Workshop

Summary

Name: Peter Ueng

Management Unit: Plant Molecular Biology Laboratory

Location: Beltsville, Maryland

Strategic Plan Code: 2.2.01.1.a 100%

Objectives / Approach:

To isolate the specific disease resistance genes of wheat against leaf blotch disease caused by Septoria tritici and define host-parasite interaction in facultative parasitism on cereal crops.

cDNA libraries representing early gene expression in the host plants during pathogenic infection will be constructed. The gene(s) specifically induced will be selected by DNA subtraction technique and differential hybridization against sequences of DNA prepared from healthy and non-specifically elicited wheat plants. The gene(s) will be further characterized by mapping and sequencing. The structure of genomic DNA counterpart of these gene(s) will be analyzed. The functional expression of disease resistance gene(s) during fungal pathogenesis will be studied. Finally the sequence motif for gene regulation in wheat will be identified.

Since the disease resistant lines used in this study are derivatives of the cultivar "Arthur", genomic clones will be isolated from this wheat cultivar and used for restriction fragment length polymorphism (RFLP) analyses to identify the disease resistance gene(s). The isolation of disease resistance gene(s) by cDNA cloning can be confirmed by the results obtained from RFLP mapping.

Status of Research:

Wheat lines which contain the Bulgaria 88 disease resistance gene and those cultivars with possibly one dominant resistance gene have been tested for response to Septoria tritici in the greenhouse. Some of the resistant lines have been propagated to produce more seeds for future use.

Hundreds of clones which were restricted by several endonucleases and subcloned into plasmid DNA have been isolated. The clones which may be useful for RFLP mapping will be selected by restriction mapping and Southern blot hybridization.

Other studies just getting underway include a study of the involvement of wheat chitinase gene in fungal disease resistance and a study of RFLP mapping of Septoria nodorum isolates. S. nodorum is another important fungal pathogen causing glume blotch disease in wheat.

New ARS Cereal Scientists Workshop

Summary

Name: Les J. Szabo

Management Unit: Cereal Rust Laboratory

Location: Saint Paul, Minnesota

Strategic Plan Code: 2.4.02.2.c 80%
2.4.02.2.g 20%

Objectives / Approach:

To develop a DNA restriction fragment length polymorphism (RFLP) genetic map of Puccinia graminis f.sp. tritici for genetic analysis and map based cloning; to develop vectors for transformation of rust fungi; to characterize the physical nature of the genome of P. graminis f.sp. tritici; and to clone avirulence genes from P. graminis f.sp. tritici.

Single copy random genomic clones will be used to determine the amount of polymorphism among a diverse set of races and parents will be selected for RFLP genetic map. Heterologous probes for highly expressed genes will be used to clone strong promoters for transformation vectors. Three-dimensional reconstructions from TEM serial sections of pachytene nuclei, renaturation kinetics, and pulsed-field gel electrophoresis will be used to determine chromosome number, and complexity.

Status of Research:

A RFLP study of 24 races of P. graminis f.sp. tritici has been initiated. This set of races include representatives of the 9 asexual avirulence/isozyme clusters, the sexual population North America, and a world wide collection. Of 98 random clones that were surveyed, 70 were low or single copy.

The genes encoding for GAPDH and HSP 70 were cloned from P. graminis f.sp. tritici and are being sequenced. The promoters from these genes will be used to drive selectable markers in a transformation vector.

Three-dimensional reconstructions of pachytene nuclei from three different races of P. graminis f.sp. tritici has been completed. A total of ten nuclei were examined and in each of these a chromosome count of 18 was obtained. Pulsed-field gel electrophoresis indicate that the chromosomes range in size from 2 to 5 million base pairs.

New ARS Cereal Scientists Workshop

Summary

Name: Victor Raboy

Management Unit: Cereal Crop Improvement Research

Location: Bozeman, Montana

Strategic Plan Code: 2.2.01.1.b 80%
2.2.03.1.c 20%

Objectives / Approach:

To advance the basic physiological, biochemical and molecular genetics of cereal crops; to elucidate the biochemical pathway to phytic acid in cereals; to isolate and characterize mutations in the pathway to phytic acid; to clone genes in the pathway to phytic acid; to develop low-phytic acid or phytic acid-free cereals.

Spring and winter wheat tissues other than the seed (pollen, root, suspension cell cultures) which accumulate phytic acid will be determined. Inositol phosphate kinases will be isolated and characterized. EMS-induced mutations in maize will be screened for those in the pathway to phytic acid. Materials and new knowledge developed will be used to further our understanding of phytic acid physiology, to elucidate the synthetic pathway to phytic acid, and to clone genes in the pathway.

Status of Research:

A study of the quantitative relationship between grain protein and phytic acid in wheat revealed that these two nutritional important components are very highly correlated. This is of importance to a traditional plant breeding approach to the "phytic acid problem". A survey of phytic acid and phosphorus in maize defective kernel (dek) mutants was completed, and shed light on the role of phytic acid synthesis in phosphorus regulation during endosperm development. A strategy for screening for phytic acid mutants in maize was developed, and is currently being implemented. A study of the role of phytic acid in winter wheat roots with regards to the hardening off process is nearing completion. A survey of phytic acid in plant cell suspension cultures was completed, and revealed that phytic acid is a common component of suspension cultures. An assay for cereal inositol phosphate kinase activity is being developed. Efforts to clone inositol metabolism genes using heterologous sequences and PCR is just getting underway.

New ARS Cereal Scientists Workshop

Summary

Name: Roy French

Management Unit: Wheat, Sorghum, and Forage Research Unit

Location: Lincoln, Nebraska

Strategic Plan Code: 2.4.04.1.g 50%
2.4.02.1.a 50%

Objectives/Approach:

To determine the molecular mechanisms for interaction between viruses, vectors, and host plants, particularly wheat, and implications of such interactions for yield loss and control; to develop molecular based virus detection systems for addressing wheat virus epidemiology.

Replication of viruses is followed in cereal protoplasts as part of a long term project to gain an understanding of how plant viruses cause disease, and investigate interactions between viral and host proteins with each other and with viral and host RNAs. A variety of mutations will be made in cDNA clones to the genomic RNAs of barley stripe mosaic virus (BSMV) and brome mosaic virus (BMV), including insertion of foreign genes, in order to examine gene function and quantitate gene expression. Techniques such as direct RNA sequencing and polymerase chain reaction (PCR) sequence amplification will be used to investigate virus variability.

Status of Research:

An immunoprecipitation assay using antiserum to double-stranded RNA was refined for the study of viral protein-RNA interactions *in vivo*. Unique, virus-specific proteins were detected in protoplasts infected with barley stripe mosaic virus (BSMV), brome mosaic virus (BMV), and tobacco mosaic virus. Deletion of the carboxyl end of a 58 kD protein encoded by BSMV RNA2 does not abolish RNA binding. A bacterial gene for glucuronidase was expressed in both BMV and BSMV and, with BMV, its level could be modulated by duplicating RNA sequences controlling subgenomic messenger RNA synthesis.

The genetic relatedness among four isolates of wheat streak mosaic virus (WSMV), hordeum mosaic virus (HMV), and agropyron mosaic virus (AMV) was compared by direct RNA sequencing. Like definitive potyviruses, these cereal viruses contain poly(A) tails. Three primers [d(T)14A, d(T)14C, or d(T)14G] were found to be sufficient for sequencing any polyadenylated RNA; other than the presence of a poly(A) tail, no prior sequence information is necessary. At least 200 3'-terminal bases were determined for WSMV and HMV. Comparison of the profiles showed that four WSMV isolates ('Wyoming', 'Sidney', 'Type', and 'Corn') were over 96% identical, while no sequence similarity existed among WSMV, HMV, and AMV.

Studies to examine the role of the host cytoskeleton in the virus life-cycle and pathogenesis and to develop general PCR probes for detecting cereal viruses have recently been initiated.

New ARS Cereal Scientists Workshop Summary

Name: Bob Graybosch

Management Unit: Wheat, Sorghum and Forage Research
Location: University of Nebraska, Lincoln, Nebraska
Strategic Plan Code: 2.2.01.1.e 80% 2.203.1c 20%

Objectives / Approach

The primary objectives of this research project are: 1. To understand genetic and biochemical factors responsible for end-use (milling, dough-handling and baking) quality of North American hard red winter wheats (HRWW), 2. To identify biochemical factors responsible for the observed environmental instability of HRWW quality, and, 3. To investigate the influence of alien chromosomes on HRWW end-use quality, understand the biochemical basis for detrimental quality effects associated with such introgressions, and develop means by which the quality of wheats carrying alien introgressions may be improved.

Storage proteins (gliadins and glutenins) of wheat that contribute (in either positive or negative manner) to HRWW quality are identified through genetic studies and biochemical characterizations using SDS-PAGE, HPLC, and through the development of monoclonal antibodies. Environmental instability of HRWW quality is investigated through the analysis of storage protein, lipid and soluble carbohydrate composition of wheat varieties harvested from ten Nebraska locations. Results of biochemical characterizations are correlated with end-use quality analyses, and variation in environmental factors. Alien introgressions are identified through characterizations of storage proteins, and through use of recombinant DNA probes. Alien chromosomal fragments that carry resistance genes for important diseases are introduced into various genetic backgrounds through traditional crossing experiments. Newly derived lines are tested for improved end-use quality parameters.

Status of Research:

A analysis of gliadin and glutenin compositions of four high protein HRWW breeding populations, and 71 independently derived experimental lines, has been completed. Correlations between individual polypeptides and quality generally were weak; however, specific proteins (rare among HRWW germplasm) with negative effects were identified. Quality of HRWW apparently is governed by the interactions of numerous protein subunits, as well as the protein content of the flours. Varietal instability for end-use quality was investigated for 11 HRWW genotypes grown at five Nebraska locations. Biochemical analysis of storage protein composition revealed that quality instability was directly related to both changes in total flour protein, and to changes in the relative proportions of the various protein classes. The ratio of gliadin to glutenin was found to vary across both genotypes and environments. Gliadins and glutenins perform different roles in dough and bread formation and function; altering the relative ratios of these two components induces changes in the quality characteristics of a given HRWW variety. Seed storage proteins have been identified that allow the isolation of wheat lines that carry the short arm of chromosome 1RS. Over 450 advanced breeding lines carrying 1RS presently are being evaluated for agronomic and quality characteristics.

New ARS Cereal Scientists Workshop

Summary

Name: Jeff Pedersen

Management Unit: Wheat, Sorghum and Forage Research

Location: Lincoln, Nebraska

Strategic Plan Code: 2.1.01.1.e - 20%
2.2.03.1.b - 80%

Objectives / Approach

To develop efficient screening procedures for sorghum feed value and productivity; to identify genetic sources of improved feed value and productivity; and to produce sorghum germplasms with improved feed value and productivity.

For grain, improvement of rate of starch digestion, extent of protein digestion, and productivity will be emphasized. Initial efforts will be in screening currently available lines and populations, followed by effort directed at exotic germplasm collections. Germplasm development will utilize both population improvement and pedigree techniques.

For forage, improvement of digestibility, hydrocyanic acid (HCN) potential, and productivity will be emphasized. Initial efforts will be concentrated in sudangrass and sorghum x sudangrass hybridization. Germplasm development will be based primarily on population improvement techniques. For both grain and forage feed value, animal validation of progress will be accomplished through cooperating projects.

Status of Research:

Grain samples of many commonly used sorghum inbred lines, and S_1 families from a regionally adapted population are being evaluated for rate of starch digestion and protein digestibility. NIRS prediction equations will be developed from these samples. Forage sorghums with known diversity for HCN potential have been sampled and will be used to develop more efficient and rapid screens for this trait.

Evaluation of sorghum productivity necessitates testing of lines in hybrid combinations. Potential female lines are normally backcrossed into male sterile cytoplasm (A^1) prior to hybrid production. An alternate hybrid production system using unsterilzed potential female lines as males is being evaluated.

New ARS Cereal Scientists Workshop

Summary

Name: Stewart M. Gray

Management Unit: Plant Protection Research

Location: Ithaca, NY

Strategic Plan Code: 2.4.02.1.q
2.4.02.1.k

Project Title: Host Plant and Aphid Vector Influences on the Epidemiology and Transmission of Barley Yellow Dwarf Virus

Objectives / Approach:

The two interrelated goals are to define the mechanisms of vector specific transmission of the viruses that cause barley yellow dwarf, and to investigate the mechanisms and epidemiological significance of host plant resistance to BYDV and aphid vectors.

Vector specific transmission of BYDV involves the recognition of virus structural proteins by membrane receptors in the aphid salivary gland. Nontransmissible isolates of BYDV are acquired by any aphid, but are excluded from the salivary gland and therefore not inoculated into the plant. The biologically active regions of virus structural proteins are being identified by monoclonal antibodies that neutralize transport of the virus through the salivary gland membrane. Membrane receptors will be identified in immuno-electron microscopy studies utilizing anti-receptor antibodies and anti-receptor peptides.

Genotypes of spring oats are being evaluated for resistance to BYDV and aphid vectors. Selection criteria include symptom expression, virus titer, yield components, and aphid transmission to and from the plant. The general mechanisms of resistance are identified and evaluated in the laboratory and greenhouse. The epidemiological significance of the various types of resistance mechanisms are evaluated in field trials.

Status of Research:

Ten monoclonal antibodies have been evaluated for their ability to neutralize virus transport in the aphid. Four antibodies inhibit transmission of one or more BYDV isolates. An additional seven monoclonal antibodies have been characterized as to their specificity in binding to the NY isolates of BYDV and are now being screened for their ability to neutralize virus transport. Anti-idiotypic antibodies have been produced to 3 neutralizing monoclonal antibodies and are being tested for their ability to bind to membrane receptors. In addition, the capsid protein gene from two BYDV isolates has been cloned into a bacterial expression vector. The in vivo generated protein will be used to map epitopes involved in aphid transmission.

Resistance that suppresses the multiplication and accumulation of BYDV has been identified in a spring oat genotype. The resistance reduces the acquisition efficiency of some BYDV isolates by their specific aphid vectors. The epidemiological studies are in progress.

New ARS Cereal Scientists Workshop

Summary

Name: Martin Carson

Management Unit: Plant Science Research

Location: Raleigh, North Carolina

Strategic Plan Code: 2.4.02.1.c 70%
2.4.02.1.g 30%

Objectives / Approach:

To determine the ability of fungal pathogens to adapt to partially resistant corn genotypes; to determine the role of cultivar X isolate X environment interactions and selection during overwintering on the ability of pathogens to adapt to partially resistant corn genotypes; identify suitable conventional and molecular (isozymes and RFLP) markers for pathogen population studies; to determine the optimal level of pathogen aggressiveness for efficient selection for partial resistance in corn; evaluate the effectiveness of selection for grain yield in disease-stress environments as a means of improving corn germplasm for both yield potential and disease resistance simultaneously.

Status of Research:

A preliminary screening of our collection of Cochliobolus heterostrophus and Exserohilum turcicum isolates for sensitivity to cycloheximide has been completed. Further refinement of the screening technique is needed to allow rapid, reliable screening of large numbers of isolates from field studies. We are currently awaiting completion of laboratory remodeling before initiating isozyme and RFLP screening of our isolates.

Preliminary theoretical calculations indicate that, under many conditions, only relatively mild selection against more parasitically fit isolates during overwintering is necessary to keep the pathogen population in equilibrium. A field test of the relative parasitic and 'overwintering' fitness of native isolates of C. heterostrophus (race 0) is currently underway. Results should indicate whether there is a cost(in reduced ability to overwinter) to increased parasitic fitness.

Other work just getting started includes the production of seed stocks for future studies, making matings between compatible isolates of C. heterostrophus to initiate selection studies in this pathogen, and the development of suitable tester isolates of E. turcicum for future genetic studies.

New ARS Cereal Scientists Workshop

Summary

Name: Steven Leath

Management Unit: Plant Science Research

Location: Raleigh, NC

Strategic Plan Code: 2.4.02.1.g 60% 2.4.04.1.g 40%

Objectives/Approach:

To determine the epidemiology and joint yield reducing effects of powdery mildew and leaf rust of wheat in the Southeast and the genetic basis of powdery mildew-wheat interactions including identification of resistance genes and determination of virulence frequency in the Erysiphe graminis f. sp. tritici populations; to introgress powdery mildew and Septoria leaf and glume blotch resistance from wild relatives into hexaploid wheat; to develop in vitro callus selection methods for Septoria nodorum resistance.

Genetic studies will involve characterized isolates and pure genetic material in controlled conditions and disease and yield assessment studies, as well as population genetic studies, are completed in the field with naturally occurring pathogen populations. Virulence analyses rely on host differential lines in both mobile nurseries and in spore traps. Gene introgression work makes use of both interspecific and intergeneric crosses and embryo rescue onto tissue culture media. Tissue culture work is underway to determine amount of somaclonal variation for agronomic and disease resistance traits, both between and among calli of a number of soft red winter wheat cultivars. Toxin extraction involves solvent extractions and flash chromatography purification with thin layer chromatography verification.

Status of Research:

The role of powdery mildew in reducing wheat yields has been examined and both the magnitude and the relationship between crop growth stage, disease levels and subsequent yield reduction detailed; the combined effects of leaf rust and powdery mildew on wheat development and yield are underway. Both deterministic and simulation models relating these factors are being developed. The virulence characteristics of the Erysiphe graminis f. sp. tritici population in North Carolina have been determined and they are being updated and expanded. Major soft red wheat cultivars are being analyzed to determine which, if any, powdery mildew resistance genes they carry. Field studies to determine if a critical virulence threshold can be associated with subsequent epidemics on cultivars with specific resistance genes are in progress. Plants in the BC_1F_2 generation have resulted from introgression of powdery mildew and glume blotch resistance from wild relatives (primarily T. monococcum) into hexaploid wheat via embryo rescue techniques. Somaclonal variation arising from between and within calli of soft red winter wheat cultivars is being quantified and toxin selected calli also are being evaluated for glume blotch resistance under field conditions. The USDA-ARS International Winter Wheat Powdery Mildew Program continues as a portion of this project. Germplasm enhancement and cooperative cultivar development efforts, as well as numerous other studies also continue.

New ARS Cereal Scientists Workshop

Summary

Name: Paul H. Sisco

Management Unit: Plant Science Research

Location: Raleigh, North Carolina

70% of Time: CWU 6645-22000-002-00D

Strategic Plan Code:	2.2.01.1.a	80%
	2.2.01.1.c	20%

Objectives / Approach:

To isolate and characterize corn genes to elucidate gene function and regulation.

Transposon tagging is being used in both random and targeted mutagenesis experiments. Targeted genes are of agronomic interest. Coding and regulatory regions will be sequenced, the putative amino acid product deduced, and monoclonal antibodies produced to antigenic regions of artificially synthesized polypeptides. Further studies of targeted genes are possible in cooperative work with other scientists.

Status of Research:

Non-targeted mutants have been identified, and tests confirming their association with transposons will be completed this summer. Large-scale experiments to identify targeted genes are in the 1990 summery nursery.

30% of Time: CWU 6645-21220-002-00D

Strategic Plan Code:	2.1.01.1.d	60%
	2.2.01.1.b	40%

Objectives / Approach:

To identify and manipulate quantitative trait loci (QTL's) in corn using molecular markers (isozymes and RFLP's) in cooperation with the laboratory of C. W. Stuber, my Research Leader.

Segregating populations are analyzed for association of agronomic traits with molecular markers. Segments associated with the traits are then combined and tested to determine whether marker-based selection can be valuable in germplasm improvement.

Status of Research:

Chromosomal segments associated with yield, maturity, plant height, and other traits have been identified. Testing of plants selected only with associated markers is underway.

New ARS Cereal Scientists Workshop

Summary

Name: Lynn Dahleen

Management Unit: Cereal Crops Research

Location: Fargo, North Dakota

Strategic Plan Code:	2.2.01.1.d	60%
	2.2.03.1.e	40%

Objectives / Approach:

Improve tissue culture techniques in barley and apply this technology to genetic transformation, in vitro selection, and production of amphidiploids from intergeneric crosses for use in barley enhancement; use molecular genetic techniques and morphological marker stocks to identify and map genes to chromosomes; identify and evaluate potentially useful traits in barley cultivars, exotic lines, and related species and incorporate them into enhanced germplasm lines for use in barley breeding programs.

Initial tissue culture work consists of immature panicle culture of intergeneric hybrids and their parents. A program of anther culture is planned. Restriction fragment length polymorphism (RFLP) analysis will be used for mapping the barley genome, and for combining the molecular and morphological marker maps. Doubled haploid lines supplied by the Barley Genome Mapping Project and near-isogenic lines carrying morphological markers will be used for the mapping project. cDNA probes will be supplied by Dr. A. Kleinhofs.

Status of Research:

This project was initiated in November, 1989, so much time has been spent on purchasing equipment and supplies, and getting the lab set up.

Tissue cultures of sterile hybrids between Hordeum vulgare and Elymus canadensis have been initiated and growing calli are being transferred to media containing colchicine to promote chromosome doubling. Direct colchicine treatment of the hybrids was not successful. Crosses are being made between H. vulgare and Pseudorogneria spicata followed by embryo rescue.

The barley genome mapping study is just getting underway and the germplasm evaluation and enhancement project is still in the planning stage.

New ARS Cereal Scientists Workshop

Summary

Name: Michael C. Edwards

Management Unit: Cereal Crops Research

Location: Fargo, North Dakota

Strategic Plan Codes: 2.4.02.1.a 90%
2.2.03.1.e 10%

Objectives/Approach:

To facilitate the development of effective measures for the control of plant virus diseases by improvement of our knowledge of host-virus interactions (especially virus-barley interactions).

My approach involves the study of three viruses: barley stripe mosaic virus (BSMV), barley yellow dwarf virus (BYDV), and oat blue dwarf virus (OBDV). The major thrust of the BSMV research is to study virus genetics and mechanisms of pathogenesis and resistance. Several avenues are being explored: 1) construction and subsequent analysis of viral cDNA clones by sequencing, pseudorecombination, and mutation techniques, 2) evaluation and characterization of BSMV strains, and 3) the study of resistance mechanisms using protoplasts. BYDV research is more "practical" and involves: 1) a search for alternative sources of resistance or tolerance, and 2) evaluation of the responses of selected commercial barley cultivars to infection with BYDV. OBDV research currently involves: 1) improvement of purification procedures, 2) characterization of the virus and its components, and 3) possible development of a protoplast system. Long-term plans include genetic analyses similar to those currently underway with BSMV.

Status of Research:

The complete genomes of BSMV strains CV17 and CV42 have been cloned into a transcription vector and the *in vitro* transcripts subsequently produced have been shown to be infectious. Results of genetic studies with these clones have indicated that RNAs α and γ are particularly important in the determination of both local and systemic pathogenicity. These studies have also given some indication of the existence of non gene-for-gene type interactions. Preliminary sequencing evidence indicates that true RNA recombination has occurred naturally in the CV17 strain. We are still in the early stages of our OBDV research. We have developed a purification procedure for OBDV and have determined the approximate molecular weights of its genomic RNA and coat protein. Preliminary results of a cooperative study of the effects of BYDV infection on commercial barley cultivars indicate that malt quality is reduced as well as yield as a result of BYDV infection. Our search for alternative sources of BYDV resistance has only recently begun.

I am also involved in a cooperative effort with D. Wesenberg (ARS, Idaho) and R. Timian (ARS, retired) to eliminate BSMV from the barley in the National Small Grains Collection and I am coordinator of the Mississippi Valley Uniform Regional Barley Nursery.

NEW ARS CEREAL SCIENTISTS WORKSHOP

SUMMARY

Name: Linda A. Grant

Management Unit: Cereal Crops Research

Location: Fargo, North Dakota

Strategic Plan Code: 2.2.03.1.c 20%
4.1.01.1.g 80%

Objectives/Approach:

To establish differences in intrinsic properties of starch isolated from selected cultivars of Hard Red Spring (HRS) and Hard Red Winter (HRW) wheat; and to determine if these differences can be correlated to end-use quality or be useful in Red Wheat Classification.

Twelve wheat cultivars were chosen according to their near infrared reflectance (NIR) hardness score, protein content and growing location. Starch isolated from each will be examined for differences in gelatinization pattern, intrinsic viscosity, swelling power and solubility patterns and starch damage. The ratio of amylose to amylopectin for each starch will be determined and finally, each starch will be fractionated into its two components, amylose and amylopectin, for further analysis. Data will be statistically analyzed to determine if any definite correlations exist.

Status of Research:

A total of twelve HRS and HRW wheat cultivars were milled into flour on a Buhler Experimental Laboratory mill. Starch was isolated, air dried and ground by hand to pass a #70 sieve. Gelatinization properties have been determined using a Visco/Amylograph, however, each starch will also be examined using Differential Scanning Calorimetry (DSC) and microscopic examination for loss of Birefringence to determine gelatinization temperature range. Starch swelling power, over the normal temperature range of gelatinization, has been completed. Solubility of the various starches in Dimethyl Sulfoxide (DMSO) has been initiated, and the intrinsic viscosity of each starch and its amylose and amylopectin components has been determined. Starch damage of each flour and corresponding starch will be examined and a statistical analysis initiated.

Another study in its preliminary stages involves the separation and examination of large and small starch granules isolated from cultivars representing the five major classes of wheat. The investigation will attempt to determine if starch granule size may be linked to quality factors.

NEW ARS CEREAL SCIENTISTS WORKSHOP

Summary

Name: Gary Hareland

Management Unit: Cereal Crops Research

Location: Fargo, North Dakota

Strategic Plan Code: 2.2.03.1.c 20%
4.1.01.1.g 80%

Objectives / Approach:

To determine variability in physical and biochemical traits of Hard Red Spring and Hard Red Winter wheats which could aid in wheat classification, varietal identification, and early generation selections, and how these traits are measured.

Classification of HRS and HRW wheats is complex because certain physical and biochemical traits are similar to each class. Traits which are under current investigation include: evaluating gluten index, dry gluten, wet gluten, and total gluten values in samples from both wheat classes, and comparing these values with other wheat characteristics; measuring enzymatic activities and evaluating specific isozyme patterns associated with each class; investigating the variability in dietary fiber, fiber components, and phytates associated with each class.

Status of Research:

Twenty-one cultivars of HRS and HRW wheats with wide ranges of physical and biochemical characteristics were assayed for gluten index, total gluten, wet gluten, and dry gluten values. Values obtained are being compared, through the use of SAS procedures, with other known characteristics of the wheat, flour, and dough.

A procedure has been modified to quickly assay peroxidase activity in wheat, oats, and barley. Currently, twenty-one cultivars of HRS and HRW wheats have been assayed for peroxidase activity. Apparent differences in activities between HRS and HRW wheats are subject to evaluation by SAS procedures. Procedures are currently being developed to evaluate and differentiate peroxidase isozyme patterns in HRS and HRW wheats through the use of electrophoresis.

Dietary fiber (total, soluble, insoluble, beta-glucans) associated with HRS and HRW wheats is being measured and further characterized. Fiber components will be analyzed for biochemical traits to include differences in carbohydrate constituents and phytates.

Name: Michael D. McMullen

Management Unit: Corn and Soybean Research

Location: Wooster, Ohio

Strategic Plan Code: 2.2.01.1.b 80%
2.2.01.1.i 20%

Objectives / Approach:

To improve virus resistance in maize through a understanding of the genetic, biological, and molecular basis of host plant resistance and the molecular basis of virus infectivity and pathogenicity. Specific objectives include: 1) characterization of the genetic and biological basis of resistance to maize dwarf mosaic virus (MDMV), 2) development of strategies that will permit the isolation of the major gene for resistance to MDMV, 3) use of RFLP analysis to characterize the basis of tolerance to maize chlorotic dwarf virus (MCDV), 4) molecular cloning and characterization of the genome of MCDV, and 5) development of efficient transformation systems for major crop plants.

Status of Research:

RFLP analysis was used to identify and genetically map the major gene for resistance to MDMV in the maize inbred, Pa405. Two approaches will be used to attempt to clone this gene we have designated *Mdm*1. The first approach will be to isolate *Mdm*1 by transposon-tagging. The second approach will be to use RFLP markers, plants recombinant for closely linked RFLP markers and resistance, and PFGE to construct a physical map around *Mdm*1 to determine the feasibility of cloning the gene based on it map position. Preliminary evidence suggests that the product of the *Mdm*1 gene may mediate resistance by blocking transport of MDMV in the vascular system.

An F_2 population between two inbred lines of maize, one highly tolerant and one highly susceptible to MCDV, is being analyzed for symptom response to MCDV and RFLP analysis will be used to locate chromosomal regions involved in tolerant responses.

cDNA clones covering most of the MCDV genome have been isolated and the corresponding DNA sequence is being obtained.

In collaboration with John Finer, Ohio State University, procedures have been developed to use particle bombardment of embryogenic suspension cultures to obtain transgenic plants for both cotton and soybean. Experiments are underway to attempt to extend this approach to maize.

New ARS Cereal Scientists Workshop

Summary

Name: David R. Porter
Management Unit: Wheat and Other Cereal Crops
Location: Stillwater, Oklahoma
Strategic Plan Code: 2.1.01.1.e 50%
2.2.03.1.c 50%

Objectives / Approach:

To reduce the impact of biological stresses of wheat and barley through development of pest-resistant germplasm; to adapt a molecular marker derived system of identifying gene products conferring host plant resistance to pests for germplasm improvement applications; to develop immunoassay screening technique for identification of sources of resistance in wheat and barley germplasm; to determine inheritance of genes controlling resistance; and to transfer resistance genes from selected wheat and barley germplasm into adapted genotypes for release.

Cultivated and related wheat and barley species exhibiting resistance to the Russian wheat aphid (RWA) and prevalent greenbug biotypes will be identified by conventional screening methodology. Once differentials have been identified, biochemical and physiological mechanisms of resistance will be characterized and molecular and/or cellular markers associated with resistance will be identified and characterized. Relationships between markers and resistance response will be established through genetic analysis protocols. Immunoassay-based screening protocols will be developed based on gene products conferring resistance. Genetic control and inheritance patterns of resistance genes will be determined through genetic analysis of segregating populations. Transfer of resistance genes will be made through conventional hybridization methodology using breeding strategies formulated from information obtained from inheritance studies.

Status of Research:

Several sources of moderate resistance to the RWA have been identified in hexaploid wheat accessions from southwest Asia. Leaf tissue has been collected from noninfested and RWA-infested susceptible and resistant plants. Characterization of differential responses to RWA feeding damage in resistant and susceptible plant types is underway through silver staining of denatured leaf proteins separated by isoelectric focussing polyacrylamide gel electrophoresis. Preliminary observations of protein profiles include: (1) reduced level of accumulation of some proteins in RWA-damaged plants, as compared with noninfested controls, (2) increased level of accumulation of some common proteins in RWA-resistant plants, as compared with susceptible plants, and (3) accumulation of unique proteins in RWA-resistant plants, as compared with susceptible plants.

New ARS Cereal Scientists Workshop

Summary

Name: Gary M. Banowetz

Management Unit: Forage Seed and Cereals Research

Location: Corvallis, Oregon

Strategic Plan Code: 2.3.01.1.h 80%
2.2.01.1.c 20%

Objectives/ Approach:

To identify molecular changes which regulate or signal the transition of wheat from vegetative to reproductive growth; this would include the identification of transcription and translation events resulting from photoinduction, meristem evocation, or vernalization-specific gene regulation; to characterize gene expression regulated by exogenously applied cytokinins which may affect vegetative/reproductive growth;

Proteins expressed in leaves, roots, and crowns of wheat plants during vernalization and photoinduction will be examined by 2-D electrophoresis to identify photoinduction or vernalization-related gene expression. Subtractive hybridization of (+) and (-) cDNA libraries prepared from leaves and roots will be used to identify sequences in leaves, roots, and crowns which signal specific stages during the transition from vegetative to reproductive growth. Similarly, 2-D electrophoresis of protein preparations and in vitro translation products, in addition to subtractive hybridization of cDNA libraries will be used to identify cytokinin-regulated gene expression in plants receiving exogenous applications of a selection of cytokinins.

Status of Research:

Phenotypic changes in response to exogenous application of isopentenyl adenosine (iPA) to wheat seedlings have been characterized. Single applications of iPA during the first two weeks after germination cause profound dwarfing of the seedlings, although this dwarfing appears to be transient. A marked inhibition of root growth occurs in response to iPA application. The single application of iPA does not appear to affect the timing of the transition from vegetative to reproductive growth. Zeatin and dihydrozeatin riboside induced similar effects. cDNA libraries prepared from leaves of iPA-treated and nontreated plants have been prepared and subtracted and clones are being analyzed to determine whether the subtracted library contains cytokinin-responsive sequences. Similar subtracted cDNA libraries are being prepared from treated and untreated root tissues.

Name: David P. Livingston III

Management Unit: Pasture Research Laboratory

Location: University Park, Pennsylvania

Strategic Plan Code: 2.2.03.1.f 60%
2.3.01.1.h 40%

Objectives / Approach:

Determine the role of fructan accumulation in freezing resistance of winter oat. b) Determine the effect of Barley Yellow Dwarf Virus (BYDV) infection on carbohydrate storage in winter oat crowns and relate those effects to freezing resistance. c) Determine the effect of reciprocal winter by spring crosses on carbohydrate accumulation, BYDV resistance and winterhardiness in winter and spring germplasm.

Status of Research:

It was found that winter oat crowns contained much lower amounts (per gram dry weight of tissue) of high Degree of Polymerization (DP) Fructan than other winter cereals. A study of fructan accumulation in Rye, Wheat, barley and oat crowns over time has been completed. Plants are being grown and hardened in growth chambers and crowns are being ground with a grinder developed specifically for grinding cereal crowns. Carbohydrates are being extracted with ethanol and water and separated and quantified using HPLC. Three analytical columns arranged in series has allowed us to separate different sized fructan up to DP9. Experiments to determine what is limiting the production of high DP fructan in oat and if/how fructan composition and distribution within the crown is related to winter survival are being planned.

Preliminary data showed that Barley Yellow Dwarf Virus alters the pattern of fructan accumulation in crowns of winter oat. A cooperative agreement was initiated with Dr. Fred Gildow (Penn State Dept of Path) to investigate the possibility that fructan synthesis enzymes are affected by the virus. Studies have begun to confirm the results and to measure enzyme activities in infected and non-infected plants. If the virus does inhibit activity of the enzyme it may explain how winter survival and spring regrowth are affected by the virus. It was also found that the virus may be translocated into crown tissue (from leaves) to a different extent in some cultivars.

New ARS Cereal Scientists Workshop

Summary

Name: Shannon R. M. Pinson

Management Unit: Rice Research Unit

Location: Beaumont, Texas

Strategic Plan Code: 2.2.03.1.d 70%
2.4.02.1.g 30%

Objectives / Approach:

The objectives of the Rice Research Unit are to 1) develop broadly useful rice germplasm; 2) conduct basic investigations of breeding methodology, quality determination, and host parasite disease reactions; 3) evaluate the milling, cooking, and processing qualities of new rice varieties and selections developed by rice breeders in the national varietal improvement program; 4) develop superior-quality, short-season rice varieties with high yield, disease and pest resistance, and desirable agronomic traits; and 5) reduce insect-related losses in harvested rice. The objectives of my portion of this unit are to 1) develop improved rice varieties, and 2) incorporate new technologies as breeding and genetic tools into the traditional breeding program at Beaumont, Texas. The new technologies being focused on are anther culture for Doubled Haploid breeding, *in vitro* selection, transformation, and correlation of agronomic traits with RFLP's.

Status of Research:

This program was begun July, 1989. Tissue culture facilities and equipment have been assembled. Southern U.S. rice varieties will be screened for anther culture capability this summer. Improved media and methods will be investigated so that this technique may be made more economical. Doubled Haploid breeding will be conducted on two types of material 1) crosses between adapted lines which have a high probability of yielding an improved variety, and 2) wide crosses which are known to require excessive inbreeding for stabilization. Methods for *in vitro* selection for resistance to rice blast (*Pyricularia*) will be investigated.

Transformation studies (co-cultivation with *Agrobacterium*, electroporation and PEG treatment of protoplasts, and pollen-tube transformation) are being conducted through collaborative efforts with three faculty members at Texas A&M. The cellular and DNA work is conducted by the faculty collaborators while the plants are grown and tested for morphological at Beaumont. Only the PEG has yielded any true transformation (confirmed with Southern blots). However, the rates of transformation have been quite low and transformation has not been reliably repeatable.

RFLP studies are being conducted through collaboration with faculty at Cornell University. Agronomic characters i.e., grain length, cooking characters, disease resistance, milling quality, and yield will be measured in Beaumont over the next two years. The inheritance of the agronomic characters will be correlated to selected, mapped RFLP probes provided by Cornell collaborators.

New ARS Cereal Scientists Workshop

Summary

Name: Prem P. Jauhar

Management Unit: Forage and Range Research Laboratory

Location: Logan, Utah

Strategic Plan Code: 2.2.02.1.a 80%
2.2.01.1.e 20%

Objectives/Approach:

To transfer desirable genes from perennial Triticeae into wheat; to assess genome relationships for formulating effective breeding programs.

The current wheat cultivars have limited genetic variability for tolerance to salt and drought, and resistance to dwarf bunt and barley yellow dwarf virus. Some species of Thinopyrum, Leymus, and Agropyron are useful sources of genes for these traits. These grasses were therefore hybridized with wheat to produce desirable germplasm. Because the Ph1b locus of wheat suppresses homoeologous pairing between alien chromosomes and wheat chromosomes, the ph1bph1b mutants were used to accelerate interspecific gene transfers. Ph1b is very helpful in discriminating between homologous and homoeologous pairing. Thus genome relationships can be reliably studied in the wheat background.

Status of Research:

Several wheat hybrids incorporating alien genomes J, E, N, P, I, JE, and JN were synthesized. To promote intergenomic pairing, ph1b-ABJE, ph1b-ABDJE, ph1b-ABDE, ph1b-ABDES, ph1b-ABDJES(?), and ph1b-ABES hybrids were synthesized. The hybrids of particular interest from the point of view of salt tolerance are between the wheat cultivar 'Fukuhokomugi' and tall wheatgrass, Thinopyrum ponticum (2n = 10x = 70). These F1 hybrids have variable pollen and seed-fertility and appear very promising for producing salt tolerant wheat germplasm. They will be backcrossed with the wheat parent. High pairing wheat x barley hybrids are very promising for introducing yellow dwarf virus resistance from barley into wheat.

Both J and E genomes were incorporated into tetraploid (AABB) and hexaploid (AABBDD) wheats. Through C-banding all the individual somatic chromosomes of J, E, A, and B genomes could be identified in the trispecific ABJE hybrids. In the J and E genomes we have also observed diagnostic gliadin bands which may be useful biochemical markers for identifying these genomes in wheat hybrids. In the presence of Ph1b there is very little pairing between the J and E genomes. However, intergenomic pairing in the ph1b-ABJE and ph1b-ABDJE hybrids should produce desirable recombinants. It was conclusively demonstrated that A and D genomes of breadwheat are much more closely related to each other than either is to the B genome. These results may have significant phylogenetic and breeding implications.

Craig F. Morris

Management Unit: Wheat Quality Laboratory of the Wheat Genetics, Quality, Physiology, and Disease Research Unit

Location: Pullman, Washington

Strategic Plan Code: 75% 4.1.01.1.g
25% 2.2.03.1.c

Objectives/Approach:

Evaluate breeders' experimental selections and wheat cultivars for functional qualities based on established U.S. market classes and subclasses; improve and develop techniques and methodology for wheat quality assessment and evaluation; understand the biochemical, genetic, and environmental bases for various wheat quality attributes at the physical and chemical level.

Traditionally, quality assessment has relied heavily on standard tests such as Buhler Milling, Brabender Quadrumat Milling, 10g mixograph, sugar-snap cookie, pup bread loaf, and other American Association of Cereal Chemists-approved methods such as ash, Falling Number, Kjeldahl nitrogen, grain test weight and flour viscosity. Although improvements are needed, the system has functioned fairly well over the last 40+ years, i.e. our current cultivars perform adequately in market channels. The basic approach will continue to employ these tests.

Status of Research:

Improvements to the evaluation system are needed largely due to the increased demands placed on U.S. wheat quality. Maintaining the status quo has meant losing market share to our competitors in the world wheat market. Improvements in the methodology of quality assessment takes two forms: improving or streamlining existing procedures and developing or adapting new procedures. Current and proposed examples of the first of these include electronic data acquisition and objective analysis of the 10g mixograph, adaptation of sifted Tecator mill whole grain meal for simultaneous NIR grain hardness, moisture and protein, and bar code identification and tracking of samples through the analysis system.

Examples of the second type include HPLC of amylase/amylopectin ratios to predict noodle texture, NIR of Quadrumat-milled flour to predict baking parameters such as sugar-snap cookie diameter (spread), Rapid Visco Analyzer analysis of starch properties of flours as well as sprouting damage. The greatest gains in our ability to assess wheat quality potentially come from a more fundamental understanding of the molecular basis of quality and functionality. This area will receive more emphasis in the future as resources become available and the project leader (C.F. Morris) becomes more familiar with the needs of our overseas buyers.

M. (Kay) Walker-Simmons

Management Unit: Wheat Genetics, Quality, Physiology & Disease Research

Location: Washington State University, Pullman, Washington

Strategic Plan Code: 4.1.02.1.e 80%
4.3.03.1.d 20%

Objectives/Approach:

To determine the molecular, biochemical and physiological events that control seed dormancy and preharvest sprouting in cereals. Emphasis is placed on the role of the plant hormone, ABA (abscisic acid) in these events. Specific aims are: (1) to determine the mode of action of ABA in maintaining seed dormancy by identifying ABA-responsive mRNAs and proteins, (2) to obtain cDNA probes for genes which function in dormant tissue, (3) to produce antibodies and develop immunoassays for the gene products and (4) to use these new molecular and biochemical markers for dormancy in the improvement of grain germination characteristics.

Genes which function in imbibed dormant tissue will be identified by comparing the mode of ABA action in embryos from dormant and nondormant seeds. Approaches include differential screening of an ABA-maintained dormant axes cDNA library, in vivo labelling of newly synthesized proteins and monoclonal antibody immunoassay of endogenous hormones.

Status of Research:

A model system for the determination of the molecular regulation of dormancy has been developed using wheat embryonic axes. With this system we have compared early events occurring when dormant and nondormant seeds are wetted, long before visible germination occurs. Clones (cDNA) for genes which function in dormant tissue have been obtained by differential screening of a dormant grain axes cDNA library. Using these cDNA clones we have discovered that levels of specific mRNAs are maintained for prolonged periods in dormant imbibed tissue. Some of these transcripts encode for a set of ABA-responsive proteins unique to dormant tissue. These proteins have been purified and antibodies are now being produced to gene fusion proteins. Work is underway to characterize and exploit these molecular and biochemical markers for genes which function in dormant tissue.

New ARS Cereal Scientists Workshop

Summary

Name: Cynthia A. Henson

Management Unit: Cereal Crops Research Unit

Location: Madison, WI

Strategic Plan Code: 2.3.01.1.g 50%
4.1.02.1.a 50%

Objectives / Approach:

To determine the roles and importance of seed carbohydrases (α-amylases, β-amylases, α-glucosidases, debranching enzymes) to hydrolysis of seed starch; to elucidate metabolic factors regulating seed starch degradation; to determine the enzymes responsible for hydrolysis of stored fructans in cereal vegetative tissues; and to elucidate effects of the environment on fructan and starch metabolism.

The contribution of the various carbohydrases and their isozymes in degradation of physiological substrates will be determined using "native" starches obtained from normal and mutant starch producing barley lines. The enzyme(s) involved in hydrolysis of barley stem fructans will be determined using commercially available substrates while native fructans are being isolated and purified.

Status of Research:

The relative contributions of the four carbohydrases to hydrolysis of barley seed starch have been statistically analyzed. The most statistically significant enzyme, other than α-amylase whose importance is well established, in native starch hydrolysis was α-glucosidase. High and low pI α-glucosidases have been isolated and purified. Their roles in germinating seed glucan metabolism are now being studied.

One fructan degrading enzyme in barley stems has been purified and characterized using fructans from dahlia, chicory, orchardgrass and wheat. As a result of these studies, we know there must be at least one other enzyme involved in the complete hydrolysis of barley fructans. Studies of effects of light upon fructan metabolism in barley leaves and stem have been conducted and the data are being analyzed.

New ARS Cereal Scientists Workshop

Summary

Name: Ron Skadsen

Management Unit: Cereal Crops Research Unit

Location: Madison, WI

Strategic Plan Code: 2.1.01.1.d 50%
4.1.01.1.g 50%

Objectives / Approach:

To determine the structure, expression and regulation of genes related to malting quality in barley.

To identify genes involved in the synthesis of (1→3)(1→4)-ß-D-glucans in oat or barley.

Gene expression differences between a high malting quality barley cultivar, Morex, and a low quality cultivar, Steptoe, will be explored to determine which genes werve to make Morex superior. Potential malting quality indicator genes will be cloned from a seedling cDNA library and tested in a RFLP analysis between these and other good vs. poor malting cultivars. Initial efforts will also focus on expression differences in the high and low pI α-amylase genes.

The glucan synthase gene will be isolated through expression cloning of mRNA from coleoptiles harvested shortly before rapid shoot elongation.

Status of Research:

Polysomal mRNA from whole seedlings of germinated Steptoe and Morex has been cloned into the lambda zap phagemid. A large unamplified library for both cultivars has been produced and is available to the barley genome mapping effort and other barley workers. Through RNA blot analysis, it was found that Steptoe produces comparatively low levels of high pI α-amylase mRNA. Digests with five restriction enzymes revealed no RFLPs between Steptoe and Morex. Also, the same number of copies of the high pI gene reside in both genomes. Several high and low pI α-amylase clones have been isolated from the above library and are currently being analyzed. Research is being pursued into the molecular basis for the difference in anylase gene activities.

USDA

AGRICULTURAL RESEARCH SERVICE

CEREAL CROPS RESEARCH

-SOME HISTORY

EDGAR L. KENDRICK

USDA/AGRICULTURAL RESEARCH SERVICE CEREAL CROPS RESEARCH – SOME HISTORY[1]

Edgar L. Kendrick[2]

EARLY CEREAL EXPERIMENTS

The first crop grown by the USDA was five acres of chinese amber sorgo planted to produce seed for distribution in 1856. The planting was near the present Department grounds in Washington, D.C.

In 1863, the present Agriculture Department grounds on the mall between 12th and 14th Streets were assigned to the Department as an experimental tract by the Commissioner of Public Buildings. In 1865, 18 kinds of corn and 62 varieties of winter wheat, mostly from France, Russia, Prussia, Great Britain, Chile, and China were sown in this tract. The next year, 66 varieties of spring wheat, 17 of oats, 13 of barley, 17 of rye, 19 of corn, and 4 of sorghum were grown. Four varieties of rice were planted, but failed to germinate.

A tragedy occurred in connection with the experiments in 1865. In July, a thunderstorm was approaching during the harvesting of the wheat plots, and in helping to put some of the wheat under shelter, Commissioner Isaac Newton, who had hurried from his office dressed warmly and wearing a silk hat, was overcome by heat and exertion. He never fully recovered from this shock which caused his death shortly thereafter. It is not

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[1] This summary history, prepared for the May 22-24, 1990 New ARS Cereal Scientists Workshop in Pocatello, Idaho, is excerpted primarily from material supplied to me by Dr. John G. Mosėman (Retired USDA/ARS) who is assembling information to be published at a later date on the Origin and History of Research Programs for Cereal Crops and Diseases in the USDA.

[2] Retired USDA/ARS/Science and Education. Currently, Director, School of Renewable Natural Resources, College of Agriculture, University of Arizona.

recorded that any USDA employee has died from over exertion in caring for cereal plots since that time.

In the fall of 1867 these cereal plots were discontinued because it was felt that an adequate field test of cereal varieties could not be made on the limited 40-acre area of the Experimental Farm. The area was then landscaped and planted to ornamentals to furnish a suitable surrounding for the new and original Department of Agriculture Building that was completed in 1868.

CEREAL TECHNOLOGY

Analyses and quality determinations of cereals were conducted in the Division of Chemistry almost from the inception of that Division in USDA. M. A. Carleton became interested in the utilization of durum wheat after introducing this crop in 1899, and entered into a cooperative arrangement with the Division of Chemistry to analyze and test durum wheat and other cereals.

In 1905, the Bureau of Chemistry began investigating the relation of crop environment to cereal grain composition in cooperation with Carleton.

In 1908, the Department's cooperative milling and baking experiments, in which samples of wheat from plot experiments at various Cereal Field Stations were sent for testing, was established at the North Dakota Agricultural Experiment Station at Fargo. Beginning with the 1915 crop, a uniform list of varieties was sent from each Station. This cooperative arrangement continued until 1916 when the Department staff was transferred to Washington, D.C. where a new laboratory of milling and baking quality was established

under the direction of J. H. Shollenberger. That Lab was continued until about 1940.

In 1924, J. A. Clark began special studies on the inheritance of protein content in wheat.

On July 1, 1929, experiments were undertaken in cooperation with the Grain Investigations to determine the quality of wheat varieties.

Quality and technological experiments with rice were conducted in cooperation with the Grain Division of the Bureau of Agricultural Economics, from time to time for several years beginning about 1931.

Quality evaluation laboratories were eventually established for each of the cereal crops.

FIELD STATIONS

Pretty complete detail of the various field station cereal trials and experiments will be available in a history that Dr. John Moseman is developing. The first field station that included significant cereal plantings was started in 1888 at Garden City, KS. From 1890 through 1900 various field station experiments were established at Manhattan, KS, Lincoln, NE, Brookings, SD and Fargo, ND. One early field station that should be called to your attention is Arlington Farm in Arlington, VA. In 1900 the War Dept. transferred this tract of land to the USDA. Corn, oats and sorghum were planted there in 1901, and the Office of Grain Investigations began at Arlington Farm in 1907 with wheat, oats and barley being grown. The Pentagon now occupies what was once Arlington Farm.

FOREIGN INTRODUCTIONS

Cereal introductions from foreign countries is reviewed briefly because many cereal crop researchers were directly involved in the early years.

In 1898, Congress appropriated $20,000 for the introduction of rare and valuable seeds and plants, from foreign sources to be tested in cooperation with State Agricultural Experimental Stations to introduce new promising varieties. These introductions began in 1898 when M. A. Carleton was sent to Russia to secure superior varieties of cereals resistant to cold, drought, and fungal diseases, and S. A. Knapp was sent to Japan to procure varieties of rice with high milling quality suitable for southwestern Louisiana. In 1897 and 1898, N. E. Hansen, Horticulturist of the South Dakota AES, while on a trip to Russia, Siberia, and Turkestan under the auspices of the U. S. Department of Agriculture, sent back numerous samples of cereals.

The most voluminous introductions of cereals resulted from special exploration trips.

In 1948, a section was established in the Division of Cereal Crops and Diseases to handle foreign introductions. The purpose was to catalog, maintain viable seed, test, classify, and distribute to research workers seed of the foreign introductions. In 1948, D. J. Ward was appointed to conduct this program at Beltsville, MD. He was succeeded by J. C. Craddock in 1958. In 1972, there were viable seeds of more that 70,000 entries in the collection. The composition was about 44 percent Triticum, 24 percent Hordeum, 17 percent Avena, 14 percent Oryza and about 1 percent Secale and Aegilops. Seeds were supplied to research scientists in the U. S. and throughout the world. Today (5/90) this valuable germplasm is housed in a modern facility at Aberdeen, Idaho completed in August

1988 and includes over 112,000 accessions.

TILLAGE AND ROTATION

While experimenting with varieties and diseases of cereals, Carleton became impressed with the desirability of conducting experiments with rotations and tillage methods in the dry land areas.

Carleton's viewpoint regarding the necessity of tillage and rotation experiments for cereals in the dry land areas was expressed in his report to the Chief of BPI for the fiscal year 1903-04 as follows: "In many cases trials of new or improved grains have failed not because of the failure of the varieties themselves, but because of very bad methods of cultivation, mistakes in the manner of seeding, etc. Moreover, it is particularly true in the semiarid districts that the method of cultivation is one of the most important things, and that proper cultivation and the proper rotation of crops accomplish perhaps more than anything else in the thorough establishment of field crops in those districts."

In 1905 an increase of $25,000 in the appropriation for several phases of grain investigation became available, one phase of which was "to determine the best methods of cultivation of grain for different districts.

Between 1907 and 1915 varietal and cultural experiments with cereals were initiated at several new field stations -- Nephi, UT; Moro and Burns, OR; Aberdeen, ID, and Lind, WA.

After 1918, the experiments on the dry land field of the Aberdeen, Idaho Station

were discontinued because of the poor crops and thereafter, the entire station was placed under irrigation. Reductions in the appropriations, beginning July 1, 1920, necessitated the dropping of support for all cereal experiments, including the tillage and rotation experiments at Burns, OR, Lind, WA and Nephi, ID. The states continued to operate the stations at those locations.

In 1928, members of the Division of Cereal Crops and Diseases were instrumental in obtaining funds for a field station at Pendleton, OR. The purpose of this new station was to test, under more favorable rainfall conditions, the more important phases of the tillage and rotation experiments that had evolved in the work at Moro.

About 1940, except for minor miscellaneous experiments, tillage and rotation experiments in the then Division of Cereal Crops and Diseases were discontinued at most locations. Tillage and rotation experiments were continued until about 1950 at the Rice Experiment Station at Crowley, LA, Biggs, CA, and Elsberry, MO.

CEREAL DISEASES

Early reports issued by the Commissioner of Agriculture frequently contained statements regarding disease of cereals, their causes and remedies. Certain varieties often were described as being resistant to rust or "blight" or "blast."

The first contribution of the Department of Agriculture to cereal pathology was a description and illustration of corn smut, corn rust and remedies for wheat bunt included in the report for 1887 of the Mycologist, Lamson-Scribner. The first USDA experiments with cereal diseases were studies of oats blast in 1880 and 1881, by B. T. Galloway and E. A.

Southworth. On March 30, 1891, W. T. Swingle was appointed to the Division of Vegetable Pathology to conduct studies of cereal disease. He wrote Farmers Bull. No. 5, "Treatment of smuts of oats and wheat," that was published in 1892, and after additional experiments he wrote Farmer Bull. 75, "The grain smuts: How they are caused and how to prevent them," published in 1898.

It was concluded, from experiments begun in 1891, that the best approach for controlling rust would be the development of rust resistant varieties. This led to the appointment M. A. Carleton in the Div. of Veg. Path. on a full-time basis on Jan. 23, 1894. Carleton came to Washington, D. C. in March, and began a search for rust resistant grains.

Carleton was the only cereal pathologist in the USDA for more than 10 years. In 1905, E. M. Freeman was appointed as Pathologist and his experiments dealt principally with the causal organisms and the life history of rusts and smuts, and the breeding for rust resistance at Univ. Farm, St. Paul, MN.

On March 1, 1913, H. B. Humphrey was appointed cereal pathologist and extensive cereal disease investigations were established under his direction. J. H. Parker was appointed at St. Paul, MN to work on cereal rusts; H. M. Woolman was appointed a part time collaborator at Pullman, WA, to assist in the bunt investigations in that State; A. G. Johnson was appointed collaborator on a half-time basis at Madison, WI to investigate Helminthosporium diseases of barley. G. H. Godfrey was appointed to take charge of rice disease investigations, with headquarters in Washington, D. C. C. W. Hungerford was appointed in 1915 to investigate stripe rust, recently discovered in the western states.

L. E. Melchers was appointed collaborator at Manhattan, KS, to investigate sorghum

smuts. The first investigation of corn diseases in the USDA began in 1916 with the appointment of W. H. Tisdale, who was assigned the investigation of Physoderma disease of corn in the South. In 1917, C. Drechsler was appointed field assistant for the study of rust epidemiology. In 1917, W. H. Weston was hired to survey and conduct investigations of downy mildew of corn and other cereals in the Philippines and other parts of the Orient. G. N. Hoffer was appointed agent to study corn root, stalk and ear rots at the Indiana SAES, another important new field of investigation.

After July 1, 1917, additional funds became available for studying cereal diseases from increased appropriations and also from war emergency funds designated for the purpose of "Stimulating Agriculture." Consequently, numerous appointments were made for field surveys to determine the losses from smut, rust and other diseases, for conducting demonstrations on smut control, and for the study of overwintering and other phases of the epidemiology of rusts.

New appropriations available on July 1, 1918, included $150,000 for barberry eradication, $100,000 for smut control, $100,000 for "black and stripe rust" investigations, and $25,000 for the study of corn disease.

During World War I the greatly augmented funds for emergency pathological problems were difficult to administer. Appointees were being continually drafted for military service and many were poorly trained for the work that they were asked to conduct. Delays in payment of salary and expenses occasionally resulted in individuals being stranded in hotels for several days until money was received to enable them to check out. One member of the staff on a field trip was arrested as a suspicious character (or probably a German spy)

and escorted to the city limits. Two others were locked up on suspicion of being draft evaders. In 1919, three barberry scouts, due to mistaken identity, were jailed and charged with bank robbery and murder.

Reduction in appropriations beginning July 1, 1920, resulted in an elimination of the extensive disease surveys, and curtailment of research programs, but permitted the organization of cereal pathology on a permanent and substantial basis. In 1918, E. C. Stakman at the University of Minnesota was given immediate charge of stem rust investigations, and he initiated and directed the barberry eradication campaign until mid-1919. In 1930, H. A. Rodenhiser was transferred to Arlington Farm, Arlington, VA to work on the smut project. The smut project was expanded in 1931 by the addition of C. S. Holton to the staff at Pullman, WA.

On April 8, 1919, H. H. McKinney was appointed at Madison, WI and after several years, he demonstrated "rosette" to be a virus disease. In 1926, he was transferred to Arlington Farm, to take charge of virus diseases of cereals.

Humphrey continued in general charge of all cereal disease investigations from March 1, 1913 until July 1, 1925, when he was succeeded by A. g. Johnson. At the time, Humphrey assumed direct charge of rust investigations.

On Sept. 25, 1933, The Division of Cereal Crops and Diseases was reorganized on a crop investigation basis, and all pathologists were assigned to one or more of the investigations.

MINOR CEREALS

From 1896 through 1955 there was considerable research activity by the USDA on rye, emmer, spelt, einkorn, buckwheat, and proso. Carleton, Leighty, Ball, Martin, Clark, Quisinberry, Salmon, Reitz, Marshall, Sando, and Morey were all involved in minor cereals research. W. J. Sando at Beltsville developed a tetraploid rye that contains a high percentage of rutin which is used to treat capillary fragility, a condition that may result in a stroke. Varietal collections are maintained for buckwheat and rye but no experiments were conducted with other minor cereals after 1955.

ORIGIN AND DEVELOPMENT OF THE RESEARCH PROGRAMS ON CEREAL CROPS IN THE USDA

Organized cereal research in the USDA was initiated in 1890 in the Division of Vegetable Pathology by B. T. Galloway and Effie A. Southworth with the studies of oats blast. W.T. Swingle was appointed to that Division in 1891 to conduct studies of rust and smut. M. A. Carleton, located at the Kansas Agricultural Experiment Station, was appointed agent of the Division also in 1891, and in 1894, he was assigned to Washington, D.C. to assume the responsibilities for the cereal disease investigations with the title of Cerealist.

When the Bureau of Plant Industry (BPI) was organized on July 1, 1901, Carleton was designated as Cerealist in charge of the Cereal Lab in the Division of Vegetable Physiology and Pathology. On July 1, 1906, the Office of Grain Investigation was established with Carleton designated as Cerealist in Charge. C. R. Ball was appointed Cerealist in Charge in 1918 and resigned that position in 1929. Next M. A. MacCall became Principal Agronomist in Charge of Cereal investigations and served until 1946, when he transferred

to the position of Assistant Chief of BPISAE (Bureau of Plant Industry, Soils, and Agricultural Engineering). Karl S. Quisenberry was then appointed Head Agronomist in Charge until 1951, when he also moved up to Assistant Chief of the BPISAE. Quisenberry's Assistant, H. A. Rodenhiser, moved up to head the Cereal Crops research when Quisenberry became an Assistant Administrator of ARS. L. A. Tatum, who had been Assistant Chief for the two previous years, succeeded Rodenhiser as Chief of the Cereal Crops Research Branch in 1957. When Lloyd Tatum transferred to a corn and sorghum research project in Africa in 1970, P. J. Fitzgerald, who had been Assistant Chief, was appointed Chief in 1970 and served until the 1972 reorganization. (Table 1 summarizes and dates organizational and leadership changes.)

Table 1

USDA CEREAL CROPS RESEARCH - 1901-1972
AGENCY HEADS AND ASSISTANTS

1901-1906	Cereal Lab, Division of Vegetable Physiology and Pathology	M. A. Carleton Cerealist in Charge	
1906-1918	Office of Grain Investigations (Office of Cereal Investigations - 1912)	M. A. Carleton Cerealist in Charge	W.M. Jardine: 1907-1910 C.R. Ball: 1910-1916 C.E. Leighty: 1916-1918
1918-1929	Office of Cereal Investigations (Office of Cereal Crops and Diseases - 1926)	C. R. Ball Cerealist	C.W. Warburton: 1918-1923 M.A. McCall: 1924-1929
1929-1946	Office of Cereal Crops and Diseases (Division of Cereal Crops and Diseases - 1931)	M. A. McCall Principal Agronomist in Charge	H.B. Humphrey: 1929-1932 A. G. Johnson: 1933-1946
1946-1951	Division of Cereal Crops and Diseases	K. S. Quisenberry Head Agronomist in Charge	H.A. Rodenhiser: 1951-1952
1952-1957	Division of Cereal Crops and Diseases (Cereal Crops Section - 1953)	H. A. Rodenhiser Head Pathologist in Charge	B.B. Bayles: 1952-1954 S.C. Salmon: 1954-1955 L.A. Tatum: 1955-1957
1957-1970	Cereal Crops Research Branch	L. A. Tatum Chief	J.P. Meiners: 1958-1965 E.L. Kendrick: 1965-1968 P.J. Fitzgerald: 1968-1970
1970-1972	Cereal Crops Research Branch	P. J. Fitzgerald Chief	Alice L. Robert: 1966-1971

BARLEY INVESTIGATIONS

In 1906 H.B. Derr was appointed to take charge of the barley investigations. He was succeeded by H. V. Harlan who continued as leader until his death in 1945. Harlan's book "One Man's Life with Barley" is a must for barley researchers. On Jan 1, 1936, G. A. Wiebe was transferred to the barley project in Washington, and was appointed Barley Investigations leader after the death of Harlan. He continued in that role until he retired in 1969. J. G. Moseman succeeded Wiebe as Barley Invest. Leader and remained in that position until the 1972 reorganization.

OAT INVESTIGATIONS

From 1902 until 1907, oat breeding was conducted by J. B. Norton. In 1907, C. W. Warburton was transferred from the Office of Farm Management to the Office of Grain Investigations to direct Oat Investigations. In 1922 T. R. Stanton, who had been Warburton's assistant since 1915, became Leader Oat Investigations and remained as Leader until he retired in 1952. H. C. Murphy, who had been with Iowa State University at Ames since 1928, succeeded Stanton as Leader Oat Investigations, transferring to Beltsville, MD, in 1955. In 1969, L. W. Briggle, who was at Beltsville in Wheat Investigations, was appointed Leader Oat Investigations following H. C. Murphy's accidental death in 1968.

WHEAT INVESTIGATIONS

From 1901 until 1912, Carleton was directly in charge of all wheat experiments.

In 1913, C. R. Ball was made agronomist in charge of western wheat investigations and C. E. Leighty was designated agronomist in charge of eastern wheat investigations.

From 1913 until 1930, wheat investigations were divided into western and eastern wheat projects. In 1931 S. C. Salmon was appointed Principal Agronomist in charge of the wheat project.

From 1931 until 1955, as leader of Wheat Investigations, Salmon made several changes. In July, 1931, B. B. Bayles was transferred to Washington, D. C. from the Mocasin, Montana Field Station to direct the whe: experiments in the pacific coast and intermountain region. Clark assumed similar responsibilities in the hard spring wheat region, and Quisenberry likewise in the hard winter wheat region. On March 1, 1936, Quisenberry's headquarters were changed from Washington, D. C. to the University of Nebraska at Lincoln. When Quisenberry went to Lincoln, C. A. Suneson, who had conducted wheat, oats, and barley investigations at Lincoln was transferred to the University of California at Davis. In the summer of 1937, Bayles took charge of the wheat experiments in the Eastern States and Suneson took over the responsibility for the wheat research in the Western States that had been supervised by Bayles. Beginning in 1937 until the reorganization in 1972 the responsibility was divided into 4 regions: the Western States, Hard Red Spring, Hard Red Winter, and Eastern States. An individual was assigned the responsibility for coordinating the research in each of these regions.

Following World War II Salmon was assigned to duty as an Agricultural Advisor on General McArthur's staff in Japan. During his absence, Quisenberry and Bayles acted as Leaders, Wheat Investigations. In 1954, when Salmon moved up, L. P. Reitz was

transferred to Beltsville as the Leader, Wheat Investigations. Reitz was Leader until the 1972 reorganization.

Corn Investigations

1907-22	C. P. Hartley - In Charge
1923-33	Dr. Ritchey - In Charge
1933-58	M. T. Jenkins - Leader

Sorghum Investigations

1907-18	C. R. Ball - In Charge
1925-53	John Martin - In Charge
1953-58	Orin Webster - In Charge

Corn and Sorghum Investigations

1958-72	G. F. Sprague - Leader

Rice Investigations

1909-30	Dr. Chanless - In Charge
1931-52	J. W. Jones - In Charge
1952-72	C. Roy Adair - Leader

All the cereal crop investigations units beginning in 1933 generally developed a breeding/genetics, germplasm, disease, quality, and uniform nursery component.

Table 2

ARS WINNERS OF THE HALL OF FAME AWARD

- AGRICULTURE -

1986

Edward S. Knipling

1987

Howard L. Backrach
Myron K. Brakke
Glenn W. Burton
Wilson A. Reeves
Ernest R. Sears
Orville A. Vogel
Cecil H. Wadleigh

1988

Francis E. Clark
Edgar E. Hartwig
Ralph E. Hodgson
Hamish N. Munro
Jose Vincent-Chandler

1989

Douglas R. Dewey
Theodore O. Diener
Karl H. Norris
John F. Sullivan

1990

Theodore C. Byerly
Gordon E. Dickerson
Robert W. Holley
Virgil A. Johnson
George Frederick Sprague

CEREAL CROPS RESEARCHERS IN ARS HALL OF FAME

Myron K. Brakke - Dr. Brakke conducted his virus research at Lincoln, NE from 1955-72 where he was associated with the University of Nebraska. In addition to the many excellent Ph.D. candidates that studied under him, he is best known for his development of the sucrose density gradient procedures and other biochemical techniques for identifying and differentiating viruses. He is also recognized as the pathologist whose papers were referred to more than any other pathologist in U.S.

Ernest R. Sears - Dr. Sears in 1936 joined the project at the University of Missouri working on cytogenetics and interspecific hybridization of wheat. In 1937, Sears began the production of aneuploids and their exploitation in the genetic analysis of common wheat. Through the use of the aneuploids, Sears determined the origin and evolution of wheat, and transferred chromosome segments from wild relatives to cultivated wheat. He developed the first set of nullisomic and monosomic lines of wheat in the variety "Chinese Spring," and many cytogenetic stocks. The nullisomic and monosomic lines and the cytogenetic stocks have been used by many scientists throughout the world in genetic studies and for variety improvement. Sears received international recognition for developing the highly rust resistant cultivar "Transfer" trough interspecific hybridization.

Orville A. Vogel - Dr. Vogel who was located at WA State University from 1931 until the 1972 reorganization, has been recognized as one of the most successful plant breeders in the United States. He crossed Norin 10, a short productive wheat introduced by Salmon

from Japan, with Brevor, a smut resistant variety. From progeny of that cross, he selected and developed the variety "Gaines," which was the first of several highly productive short strawed wheat varieties. Selections from Vogel's cross of Norin 10 by Brevor were the foundation of the short, productive, daylight insensitive varieties developed by the Rockefeller Foundation in Mexico. The "Green Revolution" in Asia resulted from those varieties. Vogel also developed small plot thrashers, planters, and harvesters which have been used by small grain breeders world wide.

Virgil A. Johnson - Dr. Johnson was coordinator of the hard red winter wheat region from 1954 to 1972 and was located at the University of Nebraska in Lincoln. He developed several high yielding varieties and initiated an ambitious program to enhance the protein quality in hard red winter wheat. That program involved screening many thousands of wheat accessions, and the establishing of an International Wheat Protein Nursery which was grown in several countries. He is recognized as one of the world's premier wheat breeders.

George F. Sprague - Dr. Sprague, who lead Corn and Sorghum Investigations from 1958-72, is a world recognized and respected plant breeder. In the early 30's, he developed the Iowa stiffstock synthetic, and today, 40% of the cornbelt varieties carry that germplasm. Early on, he emphasized and set in motion long-range research programs in quantitative genetics for corn improvement. His 1941 paper on combining ability in corn is a classic. Lastly, he had the foresight and vision to develop the Corn and Sorghum investigations so that all their basic research was fully integrated into the practical plant breeding programs. He is still active in corn research and keeping up with molecular genetics.

NEW ARS CEREAL SCIENTISTS WORKSHOP

POCATELLO, IDAHO

MAY 22-24, 1990

BREAK-OUT REPORTS

FIBER CHARACTERISTICS

Discussion Leaders: R. Skadsen and L. Szabo

(1) Future research on fiber should be driven on highly reliable nutritional studies.

(2) Future research resources in fiber research should be directed toward areas with demonstrated health benefits and enhanced efficiency of animal feeld input.

(3) Basic research:

-- chemically define the nutritionally important components of fiber

-- define roles of insoluble versus soluble fiber

-- nutritional impact on humans, poultry, swine, and ruminants

Given the current dietary trends and efficiency of feed conversion, it is expected that poultry nutritional studies will have the largest impact.

(4) USDA, ARS involvement in nutritional studies:

-- provide defined fiber components to independent study groups

-- conduct or oversee replicative double bind studies

-- ensure reliable data for future basic research on fiber

(5) Basic research needed:

Following the establishment of chemically defined, nutritional important fiber, basic research needs will be:

-- characterization of the biosynthetic pathway in a model cereal plant

-- define the developmental and spatial deposition of fiber

-- develop a more reliable, simpler, and more efficient method to quantify fiber

(6) Genetic studies:

Success will be dependent on the information provided by the above studies. Research needs:

-- identify quantitative trait loci

-- determine environmental effects on fiber deposition

-- survey germplasm for genetic diversity and alternative sources of defined fiber.

WHEAT QUALITY FOR THE FUTURE

Discussion Leaders: B. Graybosch and G. Hareland

(1) Priority research areas:

(a) Wheat classification issues:

-- classification systems based on quality and functionality

(b) Objective and rapid quality measurements:

-- on-site (at elevator) quality testing

(c) Effects of alien introgressions on quality.

(d) Breeding for quality:

-- improving both yields and quality

-- uncoupling yield gains and quality losses

-- quality attributes for specialty products and markets

-- environmentally stable varieties

-- defining and improving milling characteristics

(e) New quality concerns:

-- antistaling characteristics

-- oxidation requirements

(f) Integrated approaches to understanding wheat quality:

-- investigations of biochemical, technological, molecular, environmental, and genetic components

(2) Research needs and approaches:

(a) Encourage interdisciplinary team approaches:

-- establishment of technology support centers

(b) Enhanced support for ARS scientists working at Land Grant Institutions:

-- maintain balance in funding between regional- and university-based facilities

Wheat Quality for the Future (continued)

(c) Support for basic understanding of biochemical pathways involved in the synthesis of grain constituents.

(d) Support for germplasm development and plant breeding programs within ARS:

-- production of new materials for genetic and biochemical studies

(e) Reorganize the peer review system to recognize service oriented activities.

(f) Restructure USDA post doc program to provide 2 years support.

(3) Cooperative links:

(a) Better communication with end-users:

-- attendance at meetings involving industry

-- on-site industry visits

-- visits to foreign consumers

(b) Better interactions between regional quality labs and wheat breeding programs.

(c) Encourage communication with agricultural economists, rural sociologists, and agricultural engineers.

(d) Increased opportunities for advanced training of technical support staff.

(e) NPS should organize a national wheat meeting to include all state, federal, and industrial wheat workers.

IMPROVING VALUE-ADDED TRAITS--SPECIALTY TRAITS REPORT

Discussion Leaders: C. A. Henson, S. R. M. Pinson, L. M. Pollack, and V. Raboy

(1) Need to provide increased support for research and development of specialty uses of cereal crops.

(2) Increased diversity of uses will provide stability and economic health to the cereal industry.

(3) Increased support of basic research and fostering collaboration with market analysts, sociologists, nutritionists will allow us to anticipate future specialty market needs and problems.

(4) Specialty uses have been identified as a very important component of the future rice industry.

(5) Three areas of emphasis have been identified:

-- "premium quality: determine biochemical basis of "premium" M-401 (quality of Rexmont already identified as stable starch and measurable on the ameleograph)

-- organic rices: traditional plant breeding to increase seedling vigor, weed competitiveness (including allelopathy), disease and pest resistance

-- aromatic rices: determine economic value of aromatic character, determine if the concentration of 2-acetylpyroline correlates with aroma, further study of the genetics of other compounds contributing to aroma

(6) Needs include increased funding to support germplasm work (isoline development, development of efficient screening methods), GC-Mass Spec time, and the establishment of cooperations with biochemists, geneticists, agronomists, nutritionists, quality labs, market analysts, and sociologists.

(7) Development of specialty starches and oils for food and industrial uses.

(8) Need to support:

-- starch biochemistry research

-- starch granule size and chemical characterization

-- germplasm surveys and the development of efficient screening techniques

-- support for work in diverse locations to determine environmental effects

Improving Value-Added Traits--Specialty Traits Report (continued)

(9) A critical need in this area is the development of pilot plant technology for testing uses of new starches and oils.

(10) Need to support the development of cooperative links with nutritionists and with cereal industry and economists to study impact on current market structures and to cooperate on pilot plant technology.

(11) Need an ARS-supported maize quality lab similar to wheat quality labs.

VIRUS DISEASES

Discussion Leaders: A. Hewings and S. Gray

(1) Important virus diseases needing attention by ARS (regional importance may vary):

- -- barley yellow dwarf viruses
- -- wheat streak mosaic virus
- -- wheat/oat soilborne mosaic virus
- -- wheat spindle streak mosaic virus
- -- barley stripe mosaic virus
- -- maize chlorotic mottle virus, maize chlorotic dwarf, maize dwarf mosaic

(2) Priority research areas:

(a) Virus-vector-host interaction:

- -- mechanism of pathogenesis
- -- mechanism of host resistance
- -- mechanism of vector transmission, especially fungal mites

(b) Virus characterization:

- -- genome organization
- -- gene expression
- -- gene and gene product function

(c) Development of control strategies:

- -- disease severity control (e.g., coat protein medicated cross protection, antisense RNA technology, Ribozymer)
- -- disease incidence control (e.g., vector resistance, interference with vector transmission)

(d) Disease management:

- + field surveys--virus incidence and distribution
- -- germplasm response to virus and vectors
- -- development of improved screening procedures
- -- cultural practices

Virus Diseases (continued)

(d) Epidemiology:

-- virus populations

-- vector populations--species composition and seasonal phenology

-- development of conceptual and quantitative level

(3) Research needs:

(a) increase research support personnel:

-- competitive research associate program with 2 years minimal funding

-- category IV scientists

-- technical support

(b) Development and distribution of diagnostic reagents (e.g., category IV position).

(4) Potential new links:

(a) Competitive ARS in-house sabbatical program--opportunity for new ARS scientists (in Agency 3-10 years) to visit another ARS laboratory to do cooperative research (up to 1 year). Awards to be based on the quality of a joint research proposal.

(b) Establish link between southeast cereal pathologist and cereal virologist in north central or northeast to determine virus disease problems in southeastern United States.

FUNGAL DISEASES

Discussion Leaders: S. Leath and M. Carson

(1) Identify priority research areas:

(a) Important diseases:

-- septoria diseases of small grains

-- cereal rusts (including stripe rust on barley)

-- powdery mildew

-- cereal smuts (especially with potential loss of seed treatments)

-- gray leaf spot of corn

-- corn stalk rots

-- root diseases of small grains

(b) Disease resistance:

-- molecular basis of resistance/virulence

-- partial resistance

-- mechanisms of durability of resistance

-- broadening of germplasm base of cereals

(c) Disease management:

-- coupling of disease and host growth models

-- disease prediction and early diagnosis

(d) 'Novel' control approaches:

-- identify "targetable" systems in pathogens for possible physiological basis for control (chitinases, etc.)

(2) Identify research needs and approaches:

(a) Development of effective transformation systems for important cereals and important pathogens.

(b) Service work--germplasm evaluation, isoline development, surveys, etc.

-- technical support (i.e., category III)

(c) Support "sabbatical" leave

Fungal Diseases (continued)

(3) Identify new and/or potential links:

(a) Linkage with international centers:

-- screening for resistance to potentialy important exotic pathogens (ex. race 24 stripe rust, karnal bunt)

(b) Linkage of molecular biologists with quantitative and population geneticists, i.e., put these people at the same locations.

(c) Linkage of modelers with epidemiologists, physiologists, and ecologists, again, by grouping these individuals.

CEREAL INSECTS

Discussion Leaders: R. Shukle and D. Porter

(1) Priority research areas:

(a) Priority insects for research include:

-- Russian wheat aphid

-- Hessian fly

-- greenbug

-- corn rootworm

-- European corn borer

-- army worm

(b) Conduct basic and applied research directed toward germplasm enhancement in cereals for insect pests.

(2) Research needs and approaches:

(a) Understand the biochemical and molecular basis of virulence in the insect and resistance in the plant.

(b) Identification of resistance sources within cultivated and related cereal species for interspecific transfer of resistance genes.

(c) Identify targetable systems in insect pests which can be exploited to develop novel sources of resistance for engineering into cereals.

(d) Development of efficient marker-based screening assays for identification of resistance and analysis of genetic control.

(e) Survey field populations of insect pests to determine biotype composition and emerging virulent biotypes. Develop molecular markers for characterizing biotypes and genotypes in the field.

(f) Maintain integrity in laboratory collections of insect biotypes and insure that the collections reflect biotype diversity present in field populations.

(g) Recognize the importance of biological control in overall control strategies.

(h) Increase coordination of inter/intra agency efforts for development of resistant germplasm.

Cereal Insects (continued)

(3) Cooperative links:

(a) With other groups studying pest-plant interactions at the molecular level.

(b) With plant breeders and molecular groups working toward germplasm enhancement through breeding and genetic engineering.

GENETICS OF RESISTANCE

Discussion Leaders: R. Wise and R. French

(1) Priority research areas--enhance cereal crop yields through better understanding and utilization of genetic resistance to plant pests and pathogens.

- -- molecular basis of race-specific pest/pathogen resistance genes in small grains
- -- transformation technologies in cereal crops for horizontal transfer of natural and synthetic resistance genes
- -- basic research to facilitate transfer of quantitative resistance traits to desirable cereal varieties
- -- germplasm collection/maintenance to ensure adequate representation of world wide diversity of cereal crop species and their wild relatives

(2) Needs/approaches:

- -- establish molecular genetic maps for small grain crops
- -- develop technologies for megabase sequence and chromosome separation for physical and genetic mapping in crop plants
- -- develop heterologons and/or endogenons transposable element systems for gene tagging in small grains
- -- organize wide ranging search of cereal crop and related species for new pest/pathogen resistance genes
- -- establish continuing funding for GS-9 research affiliate post doctoral positions in research programs addressing the above priority research areas

(3) Linkages

- -- facilitate short- and medium-term interactions among ARS scientists in complementary research areas

ENVIRONMENTAL STRESS

Discussion Leader: K. Walker-Simmons and D. Livingston

(1) Priority research areas:

-- drought, low temperature, salt, and heat stress

-- additional areas include u.v. irradiation, heavy metal contamination

Due to: increased input costs, especially water

severe agricultural losses due to drought and adverse weather

increasing concerns about the "greenhouse effect" and environmental awareness

(2) Research needs and approaches:

(a) Need: A better understanding of the basic mechanisms involved in stress tolerance.

Approaches: Determination of common stress response mechanisms, such as those which enchance tolerance of tissue dehydration in both freezing and drought stress.

(b) Need: Biochemical and molecular markers for stress tolerance.

Approaches: cDNAs, RFLP markers
antibodies to critical proteins
simple physiological tests

(c) Need: Long-term evaluation of tolerant lines.

Approaches: Long-term field testing of tolerant lines. (There is a need for ARS credit in case reviews, because such testing requires considerable time and effort, but may not result in immediate publication.)

Consideration of switching to crops which tolerate stress better, such as using improved sorghum lines for feed grain instead of corn.

Identification of cultural practices which reduce exposure to stress.

Environmental Stress (continued)

(3) Cooperative links:

(a) Cooperation between scientists working on stress tolerance and researcher in LISA programs. Plants grown under LISA strategies may require additional stress tolerance.

(b) Cooperation among ARS scientists working on stress tolerance through electronic mail or bulletin boards.

GENE TRANSFER SYSTEMS

Discussion Leaders: L. Dahleen and M. McMullen

(1) Techniques:

-- support development of transformation systems specific to cereals

-- support basic research into biological processes controlling initiation and maintenance of long-term regenerable cultures for cereals-- essential for both protoplast and suspension culture approaches

-- recommendation: vice-Fromm position be filled with a cereal transformation scientist and that this person serve as a link between basic and applied research in cereals

-- support high risk research on techniques that bypass tissue culture, including recognition on case reviews

Examples: pollen tube transformation
embryo inhibition
cocultivation of meristems with Agrobacterium

-- need awareness that this research involves long-term, high risk research

-- second level priorities: promoter systems suitable for cereals

research on controlling gene expression after insertion and manipulation on the site of insertion

(2) Priority application areas:

-- pest/pathogen resistance

-- genes for enhanced nutritional/quality factors

-- environmental stress

-- transposable elements in crops currently lacking them

-- quickly focus on ribozyme control of viral diseases

-- second level priorities: male sterility systems

sequences for varietal identification and protection

Gene Transfer Systems (continued)

(3) Implementation:

-- recommendation: workshop to focus on monocot transformation techniques; attendees should include PIs and technical staff; workshop should emphasize cooperation among cell structure and physiologists

should be annual until techniques become standard

specific goal--to develop a loose-leaf transformation methods manual

-- identify, support, and publicize at least one lab per crop as a resource to assist breeders, biochemists, physiologists, pathologists, etc., in generating transgenic plants to test the effects of individual genes on complex traits--this type of collaborative research will involve multi-author publications; to encourage this type of cooperation, the efforts of co-authors must be adequately recognized and rewarded

GENE MAPPING

Discussion Leaders: P. Sisco and D. Hoffman

Our group identified seven research areas and/or needs for the subtopic of gene mapping. The group was asked to rank the seven items in order of importance. The results are as follows:

(1) Set up a workshop for ARS employees involved with gene mapping in plants.

This would include project leaders and key support personnel. The purpose of the workshop would be to discuss and demonstrate the most recent techniques for gene mapping and produce a technique manual for ARS scientists.

(2) Development and maintenance of genetic stocks for plant genome mapping.

There is a need to maintain existing stocks at defined locations and to develop new stocks in updated genetic backgrounds.

(3) Development of a communication system among ARS scientists working on gene mapping.

The purpose of this system would be the rapid exchange of ideas and new results.

(4) Development of a regional mapping center for cereal crops.

This would be a service laboratory that would allow investigators (breeders, geneticists, physiologists). Improved techniques of marker identification will need to be developed in order to make this feasible.

(5) Identify a model cereal for concentration of mapping effort.

Problems in utilizing mapping information could be solved faster with concerted effort. Information would filter down to other crops.

(6) Construct cDNA libraries for high density mapping of all major cereals.

This would give optimal information on transcribed regions of the genome.

(7) Develop and/or evaluate various methods of data analysis for associating gene markers with QTLs.

The group recognized that this could be a major limiting factor in utilizing gene marker information. The logistics of computer analysis will need to be scrutinized.

BREEDING METHODOLOGY AND CYTOGENETICS

Discussion Leaders: K. Lamkey and A. Hang

(1) Introduction:

(a) Breeding is defined to be those techniques and methods used to develop improved germplasm, not necessarily just improved cultivars. This may include such activities as basic research in theoretical and empirical quantitative genetics, recurrent selection, pedigree selection, etc.

(b) Need for national emphasis on maintaining and supporting germplasm enhancement/development/improvement.

(c) Need for national emphasis on maintaining and supporting classical genetics and cytogenetics programs.

(2) Objectives:

(a) Germplasm enhancement/development/improvement.

(b) Breeding methodology.

(c) Exotic germplasm evaluation, adaptation, and enhancement.

(d) Integration of cytogenetic, genetic, cellular, and molecular techniques into breeding programs.

(e) Transfer of genes from other species and genera.

(3) Approaches:

(a) Traditional breeding methods and approaches:

-- recurrent selection

-- pedigree selection

-- other methods (SSD, bulk, etc.)

(b) Marker assisted selection.

(c) Interspecific gene transfer.

(d) Intergeneric gene transfer or wide hybridization and control of chromosome pairing.

(e) Anther culture/double haploids.

Breeding Methodology and Cytogenetics (continued)

(4) Cooperative links:

(a) Establishment of ARS and state teams, i.e., tie together ARS positions and state positions--geneticist/breeder, pathologist/breeder, geneticist/molecular biologist.

(b) Cooperation between ARS scientists.

(c) Cooperation with the private sector where possible.

(d) Workshops.

(e) Competitive grants--encourage to obtain outside funds and encourage granting agencies to be more receptive to breeding methodology grants.